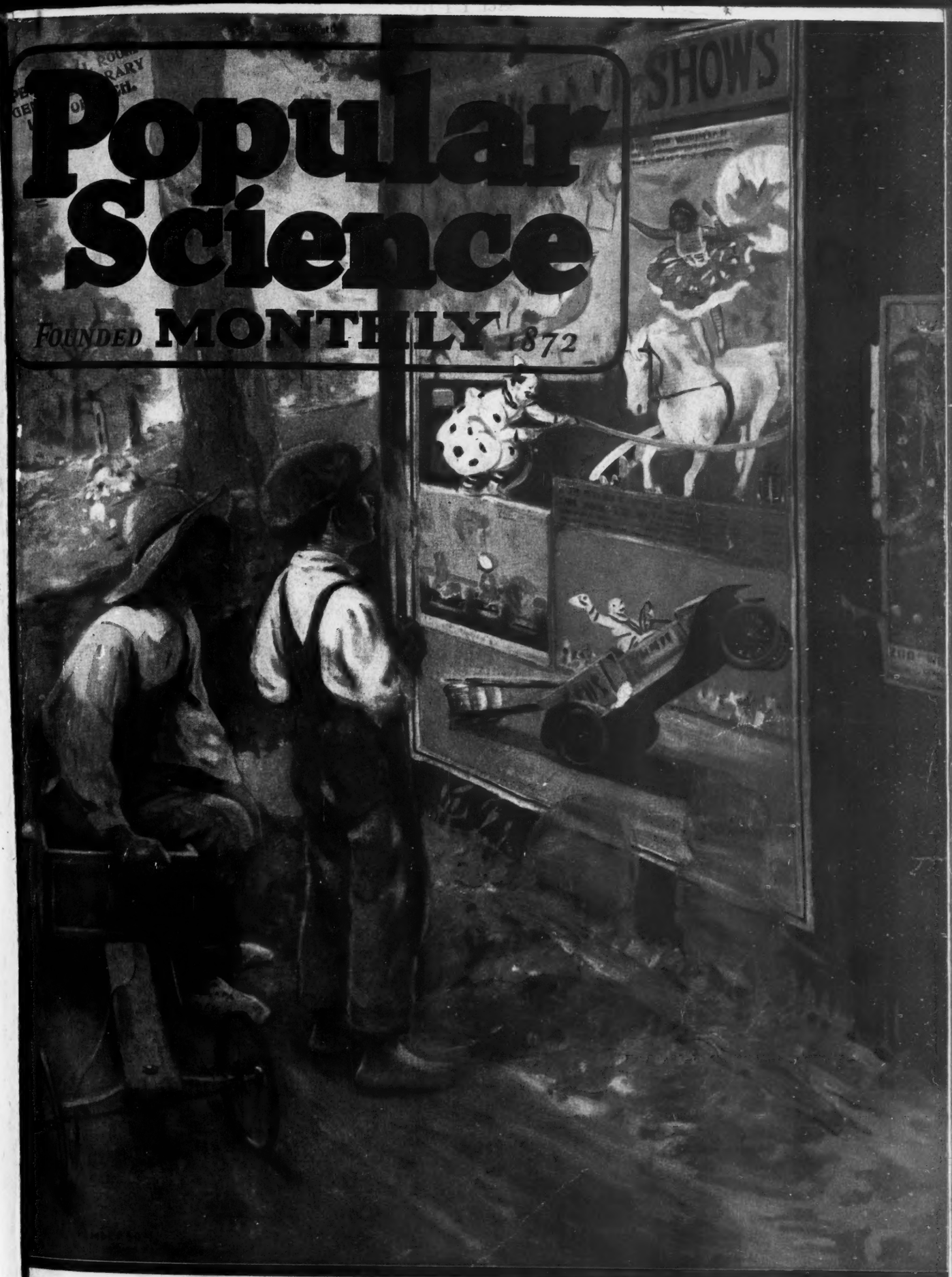

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JULY 25 CENTS

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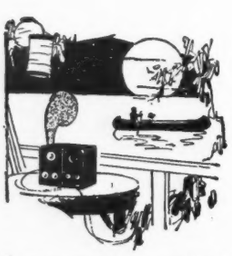

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POPULAR SCIENCE MONTHLY

JULY, 1923; Vol. 103, No. 1
25 cents a Copy; $2.50 a Year

Published in New York City at
225 West Thirty-ninth Street

SCIENCE never stands still. Progress is its underlying law. Because of its discoveries and inventions, human life is changing constantly. To realize the extent of this change one need only turn to "The Story of Man and His World," page 32 of this issue. In it Dr. E. E. Free, noted scientific writer, pictures vividly the thousands of years since human cooperation began. He tells how Maturity has gathered knowledge and passed it on to Youth. Yet, despite this vast accumulation of knowledge, signs everywhere indicate that in science and invention we have just begun.

* * *

POPULAR SCIENCE MONTHLY translates the wonders of science into terms that apply personally to the average man. This magazine is edited to serve its readers in the everyday things of life. It is edited with the *you* of the reader, rather than the *I* of the editor, as its dominating idea. In this one issue, for example, are described scores of new machines, processes, and discoveries. Each of them tends to bring human beings a few steps nearer the common goal of happiness.

* * *

THE average man's biggest task is to rule himself. He must learn to control himself before he can learn to control the elements. So it is that articles such as that on Will Power, page 25, help him get the most out of life. This month Dr. James J. Walsh, practical scientist, analyzes the average man as a chemist might analyze water. He shows him how he can develop himself by utilizing hidden and often unsuspected resources and energies. He dwells on psychology—the new science of the mind—which yet is in its infancy.

* * *

THE average man has an average body. It may be likened to an automobile engine that must see him to the end of his journey. But any engine, to operate successfully, must have care. So POPULAR SCIENCE MONTHLY publishes articles such as those on Swimming, page 43, and Vacations, page 57. In them eminent authorities show the average man how to protect his body; and how to operate it properly.

* * *

MOST men today have automobiles, or hope to have them. With car ownership come problems. So each month Harold F. Blanchard, able automotive engineer, reaches out through these pages in an effort to help solve those problems. He tells the average man how to know his car. On page 69 of this issue he has a noteworthy contribution on auto-camping. His article should save many motorists 40 per cent of the running expenses on the summer tour.

* * *

SIMILARLY, Jack Binns, famous for the last dozen years as a radio expert, has done much through this magazine to take radio from the laboratory into the home of the average man. In terms that are easily understood, he tells us of things, the knowledge of which hitherto has been confined to a little circle of technical experts. This month, page 39, he shows just how to silence shrieks and groans in sensitive radio sets.

* * *

THE average man has a home and family, or expects to have them. He wants to know how to make new and useful things for that home. He wants to know how to lighten the daily labor in his household. He wants to know how to use tools easily and quickly. Our Home Workshop and Better Shop Methods departments, pages 73 and 78, answer those wants. These departments are filled with practical hints for the man who knows the joy of doing things himself

* * *

IN SCIENCE there is imagination. And so for the average man, the curious man, the imaginative man, POPULAR SCIENCE MONTHLY is like a magic carpet. Hundreds of articles and pictures in each issue can transport him to places where men are doing new and amazing things and thinking new and significant thoughts.

See Table of Contents on page 112

POPULAR SCIENCE MONTHLY

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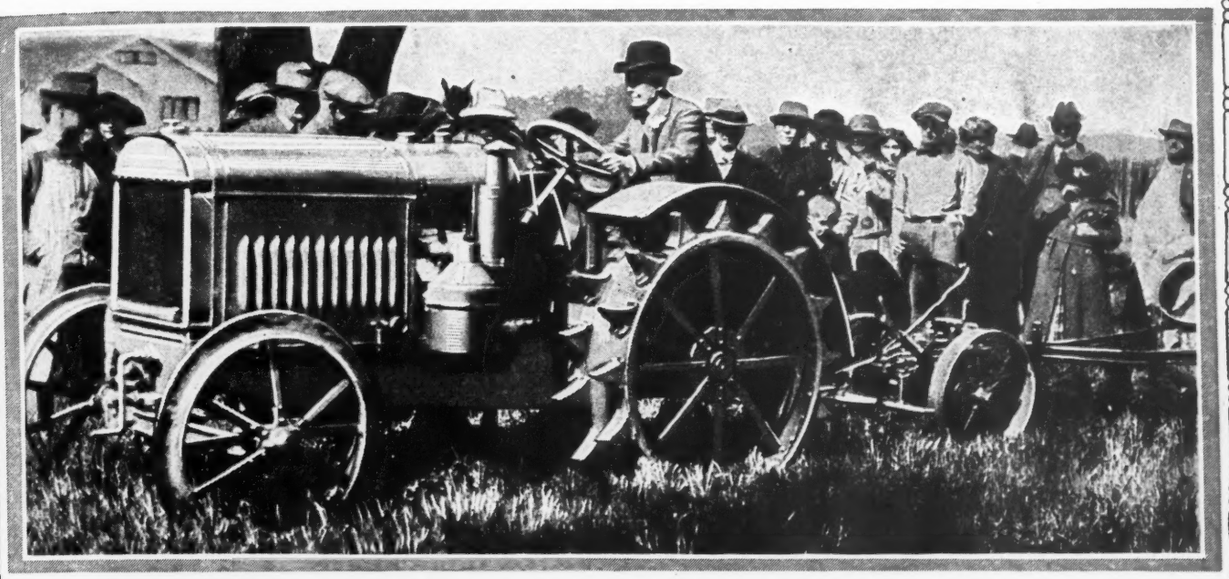
H. J. Fisher, *President*; R. C. Wilson, *Vice-President*
O. B. Capen, *Secretary and Treasurer*

THEY SAY— Brief Bits of Timely Comment from Scientists of the Hour



LUTHER BURBANK, famous plant wizard, shown above driving a tractor at the ground-breaking of a 40-acre Luther Burbank Park, dedicated in his honor at Santa Rosa, Calif., during the recent celebration of his seventy-fourth birthday:

"The motor tractor probably will not be surpassed by any other mode of soil cultivation for the next few hundred years, at least.

"On the large farm a good tractor is almost a necessity. Small tractors now are used extensively for orchard cultivation and for small farms, and still smaller tractors have been made for small gardens. Improvements in all these types will make them indispensable in cultivating the soil, although I think the horse never will go out of existence, because of its intelligence.

"In a few cases, landowners have returned to the use of horses after using tractors, but the general tendency is tremendously in the other direction."

DR. KATHERINE B. DAVIS, Director of the New York Bureau of Social Hygiene. Discussing answers to questionnaires recently sent to 1000 married women, most of them college graduates, she says:

"We are certain that in the future scientists will place at the disposal of humanity something that will help it solve the serious problems of sex relationships.

"One of the most hopeful bits of evidence about American social life is that 872 of 1000 women answered, without qualification, 'Yes' as to the happiness of their married lives."

DR. C. W. KANOLT, of the Low Temperature Laboratory, United States Bureau of Standards, who has succeeded in manufacturing solid hydrogen at a temperature of 434° F. below zero, only 25 degrees above absolute zero and probably the lowest and coldest temperature ever reached in the United States:

"Liquid hydrogen is the lightest fluid known. A cork sinks in liquid hydrogen because it is three or four times as dense as this fluid. From the liquid form, the transformation to a solid is only a single step and relatively easy. The fluid is reduced to a lower temperature—about 11 degrees on the thermometer scale—by rapid evaporation.

"Solid hydrogen resembles ice or snow and is extremely light. It is difficult to preserve hydrogen in a solid form for any duration of time."

DR. O. E. HOVEY, of the American Museum of Natural History, New York, examining a specimen of fulgurite, or "petrified thunderbolt," from Mount Ararat, Armenia, recently shown in a special exhibit at the museum:

"Fulgurite is a glass that often is produced when lightning strikes a mass of rock or a bed of dry sand and melts under the impact. In other words, it is a glass made by nature in much the same way that men make glass.

"The phenomenon is known to have occurred at a number of high points in the United States."

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POPULAR SCIENCE MONTHLY
SUMNER N. BLOSSOM, Editor
JULY, 1923

The Circus—A Mechanical Wonder Show

Thrills Made to Order from Levers, Pulleys, and Wheels

By Fred Warrell

Superintendent, Ringling Brothers-Barnum & Bailey Circus

THE lions roar. The elephants trumpet. The clowns cavort. The performers are garbed in glittering spangles. Add the smell of animals and tanbark, and you have a circus in full swing.

Yet few of the spectators realize that mechanics make the scene possible—that without mechanical magicians the circus of today could not exist. Behind its dazzling splendor and delightful odor is highly organized mechanical ingenuity.

Circus "Magic" Based on Mechanics

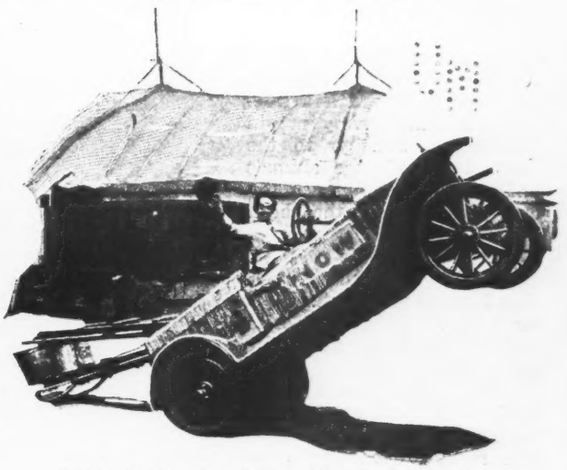
When you consider that the personnel of our circus this year includes 1786 persons, in addition to all the animals of the menagerie, wagons, and paraphernalia—equipment enough to fill 100 railroad cars—the detailed task of transporting, loading, unloading, and assembling such a huge outfit seems almost miraculous. What makes it possible is mechanics.

Most people never think of machinery when they think of the circus. That is because about a tent show is a rarefied atmosphere of splendor, which knows no care and no tomorrow. But behind it all are the five fundamental mechanical principles upon which the business of the modern circus is built and upon which its success depends:

The lever principle we use in our stake pullers; the pulley, in the block and fall; the wheel and axle, in turntable devices; the inclined plane for loading the circus train, and the screw for jacking up mired wagons. Behind our successful and most spectacular acts is an elaboration of one or more of these same principles.

Take for example, Buck Baker, the star clown, whose trick automobiles are known wherever the circus is known. He depends almost entirely on machinery to throw his audiences into spasms of mirth. More than 20 years ago Baker made the crowds laugh with his trick bicycle. In those days you may have seen him in a parade, nonchalantly riding his bicycle on its rear wheel with the front wheel spinning in the air.

Baker developed and elaborated on that original idea, using first a bicycle then an automobile, until today his trained flivver is one of the most amazing properties in the show. He has invented more than a score of clever devices for this car, each one of which required expert mechanical skill. The flivver appears almost human. It can run on its hind wheels, go backward or forward, start and stop without a driver, come when it is whistled for or called, rear up like a horse and squirt water from its radiator. Finally, as if seized with a sudden fit, it seems to blow to pieces without actually damaging itself.



Let 'er buck! Here is Buck Baker, famous circus clown-mechanic, riding his amazing trick auto that rears on its hind wheels and obeys his call

A model of the mechanical automobile hoist that Buck Baker perfected for use in repair shops as the result of his circus antics with his trick flivver. The invention is a rocking cradle that tilts a car end up. Buck is shown (at the left) in civilian clothes and (at the right) in characteristic clown make-up

Baker's Tricks Prove Valuable

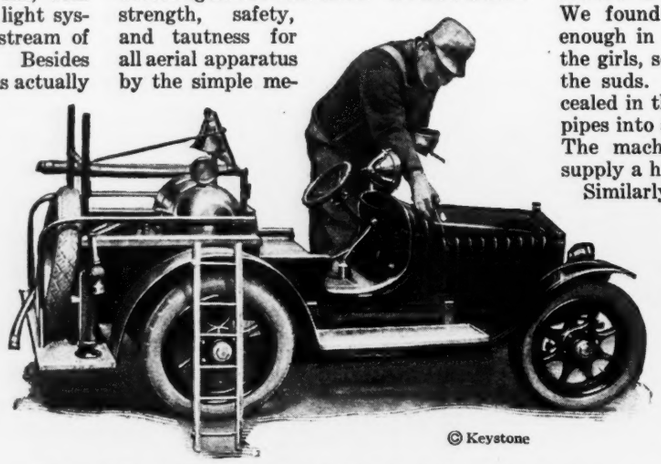
When Baker first devised a counterweight to make his car run on its hind wheels he found that the gas wouldn't run uphill to the carburetor. He built an auxiliary gas tank in the radiator. Then he found that the oil ran out of the transmission box. He installed a special pipe and washer arrangement to make it run back again. But his crowning achievement was the invention of blank cartridge guns, operated on the principle of the spring rat-trap, to cause exaggerated explosions in the flivver. He used the same apparatus to release fastenings at the right moment so that the car seemed to blow to pieces.

One of Baker's best stunts is to stand off about 50 feet from the car and call it to him. Just how he makes the flivver obey is his own secret. "It's just a simple matter of mechanics," is all he will say.

From experiments with this trick car Baker has perfected an automobile hoist that is now on the market. In repairing his car on the lot at Memphis a couple of years

ago, he raised it on its back wheels. The idea came to him that a device for tilting cars in a similar manner would be extremely valuable in garages or repair shops; so he invented the hoist.

With the help of the boss electrician, Baker also built a miniature fire department, used in the show. He worked on this for four months last winter. The fire trucks are complete in every detail, with four speeds, self starter, electric light system, and engine for throwing a stream of water from a two-inch hose. Besides amusing the crowds, the apparatus actually affords fire protection during the show. Now Baker plans to improve the miniature trucks and put them on the market as fire protection for large industrial plants.



© Keystone

The world's smallest motorized fire truck, designed for the circus midgets' fire department by Buck Baker, clown-mechanic, with the aid of the boss electrician. The machine is complete in every detail. Its hose throws a powerful two-inch stream of water

Thrillers Made Safe

Just as inventive genius has developed Baker's clown act, so has it improved and safeguarded almost every act in the show. You go to the circus to watch the animals and performers; but actually our mechanics are the show. We couldn't operate without them.

Consider the animal acts that have been our stand-bys for years. Once our chief problem was to offer something new each year. Now our mechanics supply the novelties. You have an expert mechanic to thank for your amusement in watching bears ride bicycles. This expert worked a year making one bicycle. His difficulty was to build a wheel light enough to be handled by the bear, strong enough to hold the animal's weight, and at the same time one that would fit. A bear can't bend over like a human on a bicycle. He must sit upright—really stand. The seat, handlebars and pedals had to be designed carefully to suit him. The position of the handlebars, made in the shape of small forks in which the bear lodges his paws, and of the pedals, in the form of wooden cylinders, was changed dozens of time before it was exactly right.

Even the tumbling dog depends on mechanical devices to perform his stunts. His landing platform is an ingenious arrangement of springs inclosed in pipes concealed beneath a covering. When he lands, the springs give and rebound, aiding the dog in his work.

The first "living statue" acts staged by the circus sometimes were spoiled by the jerking motion of the old style turntables that threw the horses and riders out of their rigid balance. To overcome this, we went back to the old wheel-and-axle principle of mechanics and created a table mounted on a platform made of angle iron. The apparatus is operated by means of a crank and ratchet engaging a circle of pins that turns the top on roller bearings. The thing is so nicely balanced that a man concealed beneath it can operate it with one hand at a slow, even speed.

Mechanics have been responsible, too, for the safety and perfection of modern aerial acts. As these acts became more daring with an increasing number of performers, we found that the old style apparatus wouldn't do. This was proved in Flint, Mich., about 15 years ago. At that time we used a chain block hauled on by a big crew of men to tauten the tight wire apparatus. One night a link of the chain snapped, hurling the performers into the life net. Part of the broken block and chain hit our boss property man in the head and nearly killed him. Since then he never has used a chain because of the difficulty in detecting flaws in the links. We now obtain strength, safety, and tautness for all aerial apparatus by the simple mechanics of a triple block and fall, which in turn is hauled on by a double block, so that one man can exert a pull of several tons. Much unnecessary labor as well as danger of accident have been eliminated by this method, since ropes are easily inspected.

Another accident that taught us a lesson in mechanics occurred in Albany, N. Y., three years ago. We were using the usual hook arrangement on a block and fall for suspending a gag to be gripped between the teeth of performers in a teeth-swinging act. We had a tape mousing over the hook and to all appearances it was absolutely safe. On this night, however, the ring slipped out of the hook and was supported only by the tape mousing. When Beatrice Sweeney, one of our star performers, let go with both hands to swing by her teeth she fell 35 feet. She was in the hospital 12 weeks and that was the end of the hook-and-mousing arrangement. In place of hooks we now use wire loops fastened into the iron strap of the block.

Mechanics again came to our aid when we put on our big soap bubble spectacle. The idea was to have a large egg-shaped float on which about a dozen girls would stand and blow bubbles up to the crowds. We found we couldn't make suds fast enough in the ordinary way to supply all the girls, so we invented a machine to mix the suds. This consists of a motor concealed in the float which blows air through pipes into a trough filled with soapy water. The machine can make enough suds to supply a hundred bubble blowers.

Similarly, it is mechanical ingenuity that enables us to remove so quickly the big steel arenas in which the lions and tigers perform at the opening of the show. These cages are made in sections 16 feet high by four feet wide. They are fastened together by special clamps that make the whole structure secure without the use of bolts or nuts. The clamps cannot be loosened unless they are tapped in a certain way. While they hold as solidly as welding, they may be removed in about a second, affording the speed necessary to get the cages out of the ring for the next act.

Many people regard the circus as a makeshift amusement enterprise, here today and gone tomorrow. As a matter of fact, it is a highly organized business, the transitory nature of which depends primarily on the mechanical efficiency of its workers and their inventive genius.

For example, it would be impossible without mechanical skill simplified to the last degree, to conjure up a large tented city from a vacant lot in three hours!

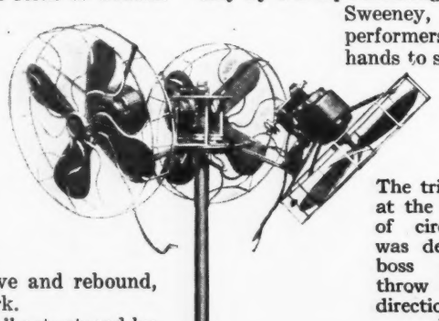
How the "Big Top" is Erected

In the old days, with a small tent, the boss canvasman had little trouble putting the show up by hand in one piece. As the tents grew in size—today our big top is 510 feet long by 210 feet wide—new methods had to be devised. Our big top now consists of 18 sections of canvas, the size of the center pieces being 100 by 60 feet. With their iron rings and ropes attached, each of these sections weigh 1500 pounds when dry and more than 3000 pounds when wet. We lace them all together on the ground and hoist them mechanically as one piece.

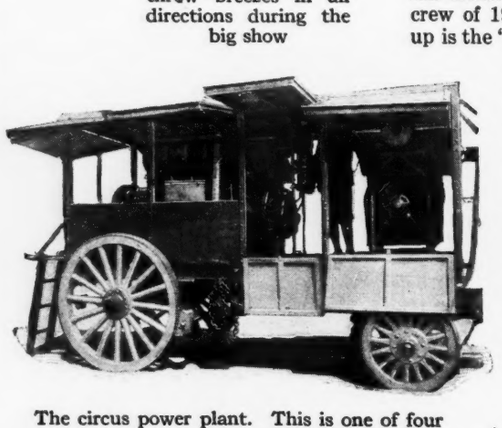
Our boss canvasman uses the block and fall exclusively for this work, employing a crew of 190 men. The first thing he puts up is the "king" pole—the first of the center poles. This is the key for all the hemp girders of the circus tent. We use ropes for girders, where other builders use steel or wooden runners.

The king pole is hoisted by means of a series of "bull" poles driven into the ground to form an abutment and also an anchorage for the block and fall. The pole is raised a little way by hand and then the block and fall pulls it up. The king pole then acts as a derrick by which the other five center poles are raised.

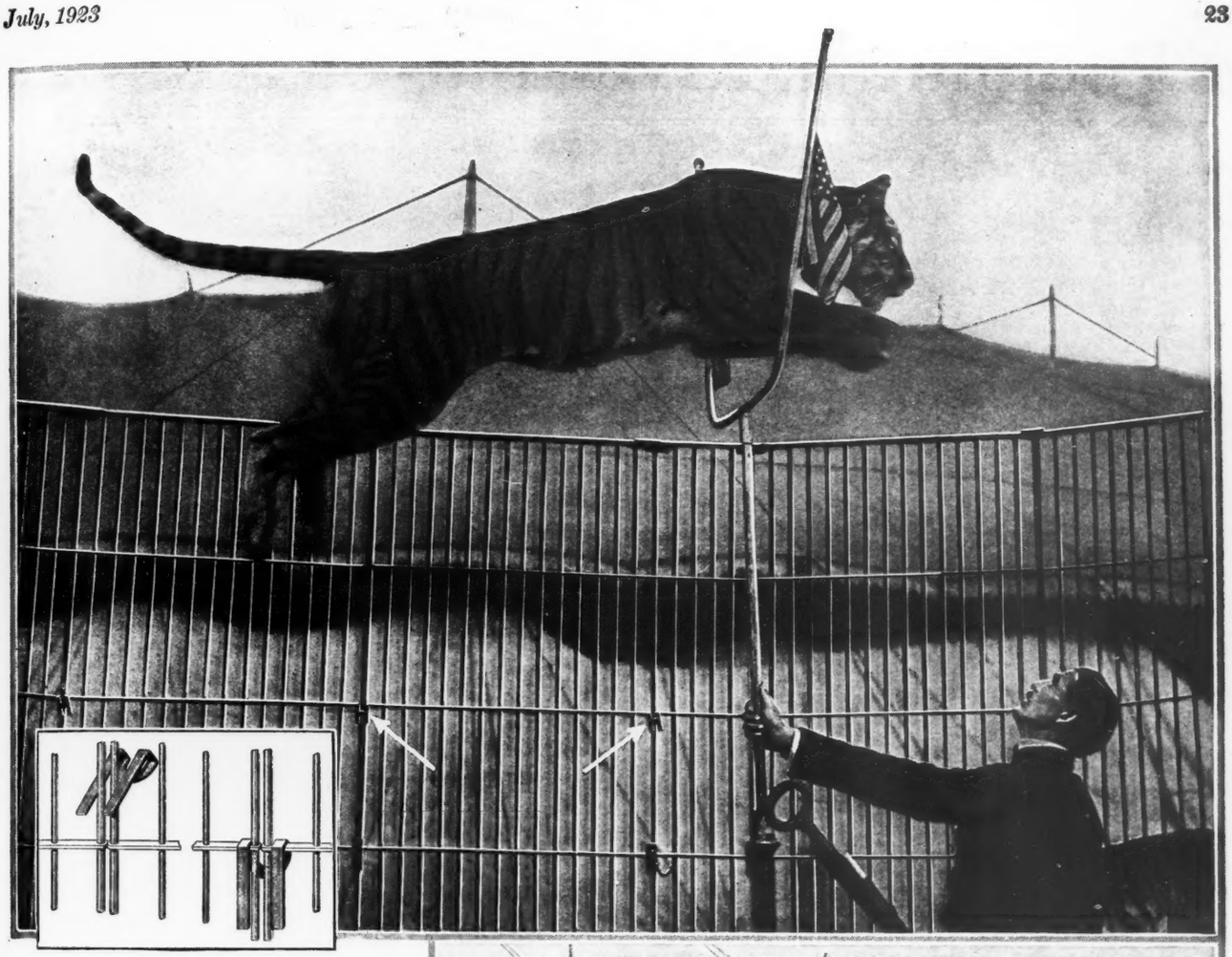
Each pole is encircled by a bail ring to which the canvas of the big top is fastened. The top is then run up by block and fall,



The triple electric fan at the left, a product of circus ingenuity, was designed by the boss electrician to throw breezes in all directions during the big show



The circus power plant. This is one of four wagon generators that supply electricity for the lighting and ventilating systems



When the tiger leaps the hurdle in the big cage, spectators can enjoy all the thrills without fear of danger, thanks to a cleverly devised clamp that fastens the sections of steel bars together securely without bolts, as shown in the inset. The picture shows the cage during practice, without the top bars

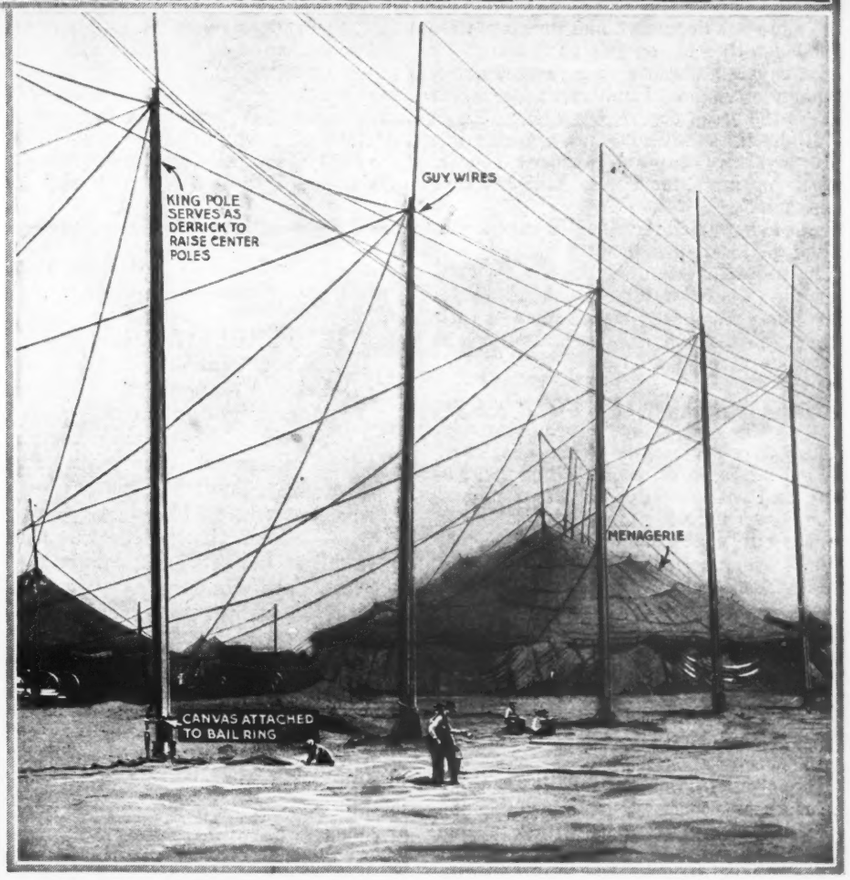
the mechanical stake driver and sledge crews in the meantime having driven the anchor stakes to hold the tent canvas rigid.

As soon as the big canvas clears the ground, the seat crews get busy. We use just three pieces in our seats—jacks for supports, stringers resting on the jacks, and seat boards resting on the stringers. All are fastened together with clamps and they go up like magic. When they are in place, they are as strong as any grandstand, because they are built on the same mechanical principle. In all our experience they never have collapsed.

Accompanying the seat crews beneath the rising canvas are the electrical crews. Electricity long ago replaced the flaming gas torch in the circus lighting system. Cables from the four big generators we carry with us on wagons are strung into the tent and leaders are fastened to bail rings. These rings carry the lights overhead and the whole lighting system is up in a jiffy. The electric calliope is plugged in, the fans are connected, and we are ready for the big night.

Electric fans for the circus are a new departure this year. When we sought to obtain a fan that would throw breezes in every direction, electricians told us no such fan could be manufactured. Our boss electrician wasn't satisfied with that answer. He wanted the fan so badly that he invented one himself, and had 70 of them made for us by manufacturers of electrical

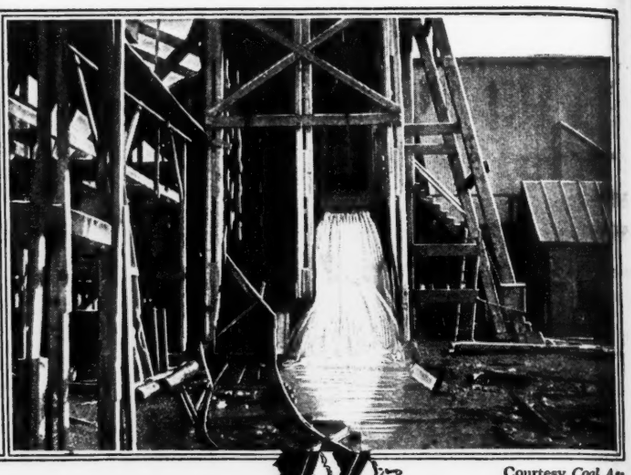
(*Turn to page 83*)



Raising the big top. First is hoisted the "king pole," which serves as the key for all the rope girders of the circus tent. The king pole then serves as a derrick to raise the remaining center poles. The canvas, in 18 huge sections, is spread on the ground and fastened to the poles through bail rings, as shown above. Finally, the top is hauled up the poles and anchored by a mechanical stake-driver. Meanwhile the seats are being erected by crews of workmen

Pumping a River out of a Mine

This lake, covering almost an acre, was formed when flood waters broke through the slate roof of the mine, flooding the workings



Courtesy *Coal Age*

Above, the water boxes in action, hoisting 3,000,000 gallons a day from the flooded mine. The boxes, equipped with flap valves, were lowered down the mine shaft

Novel Water Hoist Saves 300,000 Tons of Fuel

WHEN flood waters of the Big Muddy River suddenly roared through a break in the roof of Coal Mine No. 9 at Murphysboro, southern Illinois, a few months ago, engineers said the mine was doomed. The workings were flooded with a billion gallons of water. A lake, covering about an acre, rested above the underground chambers at the point where the break occurred.

It looked as if 300,000 tons of high grade Murphysboro coal and at least $50,000 worth of mine machinery and trackage were lost.

But nobody had reckoned on the ingenuity of W. J. Jenkins, general manager, and C. L. Moorman, chief engineer, of the Consolidated Coal Co., of St. Louis, owners of the mine. While engineers smiled at their nerve, they set out to hoist and pump the river out of their mine!

Owners Invent Salvaging Process

And they succeeded. With ingeniously devised hoist boxes, each holding 700 gallons, and with electric centrifugal pumps, they dipped and pumped that billion gallons out, at the rate of about 5,000,000 gallons every 24 hours.

Previously, with layers of brush, timber, mattresses and earth, they had plugged the deep hole in the mine roof formed by inrushing waters. With timbers, earth, and hay, they also solidly blocked the underground passages leading from the hole in the roof, making the mine practically watertight, even while the small lake remained at the surface above.

The ingenious apparatus used in dipping the river out consisted of two 700-gallon water boxes, each equipped with a bottom flap valve, and a hinged end gate that opened inwardly by a double crank mechanism. These boxes were hung in the hoist shaft and lowered alternately into the flooded workings. The filling and discharge of the boxes were automatic.

For two months the boxes were in operation 24 hours a day, making an average of three hoists a minute and discharging about 3,000,000 gallons a day. In addition, an electric centrifugal pump mounted on a platform in the airshaft ejected about 2,000,000 gallons a day in a steady stream.

As soon as the shaft bottom was clear of water, three steam pumps near the shaft were reclaimed and put in operation and two more centrifugal pumps were installed.

The machinery has been recovered, and the 300,000 tons of coal is now coming out of the shaft at the rate of 1000 tons a day.

U. S. Senator Capper on Pedigreed People

PEDIGREED families.

Blue ribbon fathers and mothers. Prize babies.

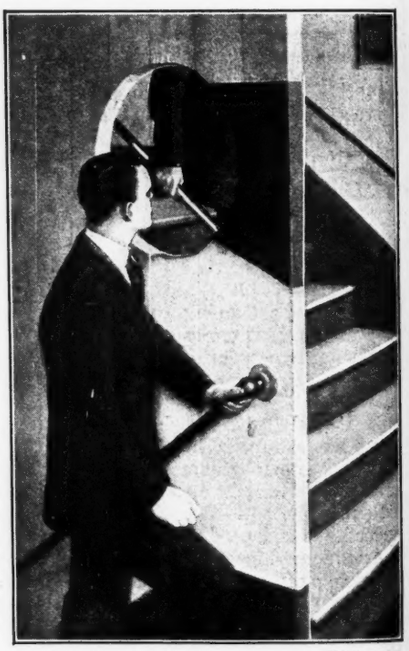
Blooded human stock.

Science, in developing better herds of animals, has perfected a highly efficient system of registration and breeding. But what about the better human family? Our records, our pedigrees, are limited at present largely to the family Bible and the Social Register.

In next month's issue of POPULAR SCIENCE MONTHLY. Arthur Capper, of Kansas, leader of the farm bloc in the Senate, will describe a remarkable experiment his state is making in eugenics—the science of fitter families.

For years Senator Capper has worked for the welfare of Kansas. When he speaks of Kansas, he speaks of his own, and with authority.

Opening in Stair Partition Averts Collisions



Showing how hole saves a collision

SHARP turns on stair landings are sometimes the cause of serious accidents in factories and other buildings in which many persons have to use the stairways.

A busy employee, carrying a heavy load, hurries around the corner and collides with a man descending from an upper floor, because he did not see the man in time to avoid the accident.

If a hole is made in the partition between the two flights of stairs, those going up can see and be seen by those coming down and collisions will be averted.

Will Power—Man's Best Ally

New Science Reveals that Health and Success Depend Largely on Ability of the Mind to Summon Reserves of Human Energy

By James J. Walsh, M. D., Ph. D.,
Professor of Physiological Psychology, Cathedral College, New York

THE other day, when Christy Matthewson, one of the greatest baseball pitchers in history, returned after a long absence to his old haunts at the Polo Grounds in New York, he was greeted as the hero of a contest eclipsing even those famous diamond battles of old, when he pitched the New York Giants out of many a crisis.

It was the contest of one man's will power against disease.

At the pinnacle of his fame, "Matty" left the baseball diamond to grapple with the most relentless opponent of his career—the great white plague. He returned victorious, as part owner of the Boston club of the National League.

Why Matthewson Won

His dramatic "comeback" was just one more striking demonstration of what will power can accomplish for the man who makes up his mind to do a thing.

How did Matthewson win where countless others have failed?

Simply by calling on latent reserves of energy within himself — by exerting sheer will power to tap successive layers of hidden and unsuspected strength.

"Tuberculosis always takes the quitters first," he heard his physicians say.

"Matty" simply refused to be a quitter.

Every baseball fan knows of the valiant fight that followed; of how the man who time and again had pitched his team to victory matched the power of his will against disease. It was no soft job for him to renounce a spectacular career; to live a recluse life out of doors in the bitter cold of winter and in the heat of summer; to eat what he didn't like; to obey physicians' orders; to keep from worrying, and even to deny himself the news of championship ball games. But he had the will to go through with it; and he won.

This ability to lay hold of secret storehouses within ourselves—this quality we call will power—is man's greatest asset. By exercising it, we can attain health, happiness, and success in their fullest measure.

We use the phrase, "making up our mind," but what we mean is, "making up our will." This "making up our will" and using it as a whip to drive the body beyond the point of first fatigue is as much a factor of success in everyday work and play—in the workshop, in the office, or on the athletic field—as it is in the fight of science against disease. Most people believe any such exertion of the will is quite impossible. That is because they never have tried seriously to use their wills. But athletes know that in striving for new records, they must train not only their muscles, but their wills as well, if they are to accomplish what they set out to do.

Christy Matthewson, former world famous baseball pitcher of the New York Giants, who by sheer will power won an uphill fight against tuberculosis, and who now is part owner of the Boston club of the National League

William James, noted professor of psychology at Harvard University, used to emphasize the place of the will in human life by referring to what is known in athletics as "second wind."

In the course of training, nearly every athlete reaches a point where, having run a certain distance or accomplished certain feats, he seems unable to do more. His breath grows short, a sense of tightness comes around his chest, his heart seems to be crowded, his feet become heavy. He feels as if he must give up.

"Second Wind" Explained

Here is the crucial test. If he lacks the mental stamina of an athlete he *will* give up. If he is unable to exercise will power to draw further on his energy resources, he never will become a successful athlete. But if he pushes on, confident that his heart, lungs and other organs are in good condition, and determined to go the limit of his powers, a remarkable thing happens. His breath begins to come easier, the tightness around his chest is relieved, his heart seems to act with less effort, his feet grow lighter. He discovers all at once that he can go on for another prolonged period. He has his "second wind."

Marathon runners sometimes get a third and even a fourth "wind," continuing on their course when it would seem humanly impossible. And, strange to say, this drawing upon the deeper layers of unsuspected energy, leads not to exhaustion but to larger usefulness and availibility of natural energies.

This was proved by a committee of eminent physicians who examined contestants in the recent American marathon at Boston, Mass. The examinations revealed that the runners suffered no ill effects from their 25-mile grind. More significant still, there was no trace of the so-called "athletic heart." That bugaboo of athletes was proved to be a myth by comparative X-ray photographs of the runners' hearts at the start of the race and at the finish.

UNTIL recently we knew as little of the human mind as a lightning bug knows of electricity. But modern science is discovering in it resources of hidden power that hold the secrets of happiness, health, and success.

In the series of articles, of which this is the second, Doctor Walsh, one of America's most noted physicians, tells what scientists are learning of these unseen forces. He shows how we can control and use them.

Next month he will write on autosuggestion. He will tell what it means and in simple terms will show how the average person can use it scientifically to get the most out of life.

One of the most interesting disclosures of the test was that the winner, Clarence De Mar, although possessing unusual wind power, had less of it than other runners who finished far down the list. This tended to prove that in the exertion of driving the body's physical strength is secondary to will power and that a man of ordinary physique often can achieve goals far beyond his apparent ability if he exerts the strength of will.

Most of us fail to put forth our best efforts because we do not train our wills to accomplish the utmost that they can. We stop at the first barrier of fatigue. In matters of health, this becomes very important. The man who has failed to develop his will as a reinforcement against the inroads of disease, often gives up and dies, where another man, by tapping his deeper layers of energy, not only conquers the disease but lives on for many useful years.

Fear May Cause Death

In modern practice competent physicians everywhere recognize that the will to live is an all-important factor in any cure. Thus a patient is carefully guarded from news that might cause discouragement or fear of dying —such as news of the death of another person suffering from the same ailment. Any physician will tell you that the patient who gives up is the hardest of all to cure.

In pneumonia, this will to live is extremely important; for the nature of the disease tends to scare the patient. Rapid breathing, and a heart that is laboring to pump blood through a congested lung are symptoms that terrify any but the strong willed. By preventing the patient's using his vitality to the best advantage, the fear itself may be the actual cause of death.

Overcoming of disease is only one phase of the application of will power in the business of living.

Consider your own case for a moment. Go over in your mind the things you shirked or left only half done today because they were hard. Ask yourself whether you put your best effort into your tasks. The result of this self-examination may surprise you.

Wishing and Willing

I have talked with young men who believed they were putting their best into their work, yet complained that they were not attaining the success they believed was their due. On close questioning I have found invariably that they were accustomed to do well the things they enjoyed, but that they shirked the part of their duties that required effort. They just couldn't force themselves to do the disagreeable things.

A salesman I know was a typical example of this class. He had exceptional ability and closed a high percentage of his prospects; but he never headed the list of salesmen of his firm in amount of business. In talking with him, I discovered the trouble. He was in a rut. He had formed the practice of limiting his work to certain hours, beyond which he could not work. He figured on making just six calls a day. Even if he were successful in these, he never would make the seventh call. He considered he had done a day's work and couldn't force himself to do any more.

I saw him recently and he told me he was leading his firm in sales. When I asked him if he had changed his sales arguments, he laughed and said,

"No, just my habits."

This young man had checked up on himself and had found that he was becoming grooved in the "pretty good" class simply because he lacked the will power to do things he didn't like to do, such as working after 4 P.M. and before 10 A.M. He made up his mind to work harder; to extend himself. The result was that he discovered he could call on many more prospects in one day than he had believed possible.

Many inventors are like this salesman. They conceive wonderful ideas and half work them out. Then they shelve them, always intending to complete them, but never exercising the will power to overcome the obstacles that caused them to "put off."

The popular belief that a man must have a strong body to have a strong will is erroneous. Theodore Roosevelt was somewhat delicate and weakly as a boy. Only his indomitable will enabled him to use every energy and to rise to a position of extraordinary power and influence.

Will Power in Marathon Dance

Sometimes the force of an original idea will stimulate in a person the sudden development of amazing will power. During the recent craze of marathon dancing, numbers of young men and women who never before had exhibited any great amount of reserve energy, proved, under the stimulus of the idea of endurance, to have powers that no one, least of all themselves, ever thought they had. Will power gone to waste, perhaps, but will power, none the less.

Most of us fail to distinguish between *wanting* to do a thing and *wishing* to do it. Indeed, many persons, when they say "I want to do a thing," mean they would like to do it, but they feel that they cannot do it. That is why M. Coué, the druggist healer of Nancy, France, declares that when the will and the imagination come in conflict, the imagination always carries off the victory. What he really is referring to, however, is not the *will*, but the "wish" to do something with the feeling already half aroused that it cannot be done.

Extent of "Will Cure"

Coué's successes in healing by autosuggestion simply show what can be accomplished by will power once a person's mind is brought into a favorable condition for the employment of it. Patients who had been miserable apparently were restored to health by Coué, after their wills had been aroused to enable them to throw off their affliction.

The average person can cure almost any common ailment if he will really set his will to the task. He may not be able to cure cancer or organic disease in this way, but he can cure most of the functional diseases and relieve symptoms, even of the severe organic affections.

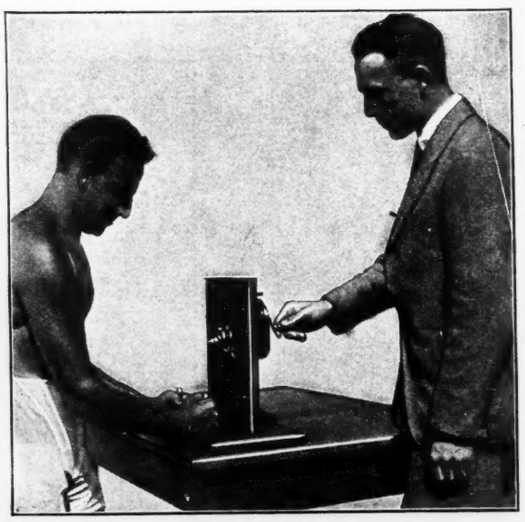
And—anybody can cure his own laziness, at least. That is one of the most important cures in life.

The Will to Win

Grim determination, expressed here on the face of Bob La Gendre, famous track athlete of Georgetown University, won for him the Pentathlon — the intercollegiate all-round athletic championship in 1919, 1921, and 1922. He won by exerting his will power to draw upon hidden reserves of energy

Machine to Test Will Power

THIS electrical apparatus for testing human will power and energy was perfected recently by Dr. R. W. Schulte, psychophysicist of Berlin, Germany, who claims to have demonstrated that will power and health go together. In the test the athlete grasps two conducting rods, through which bodily energy is said to be converted into electrical power to run a small dynamo. The rate at which the dynamo is forced to run, it is claimed, measures the will-energy of the subject. The photograph shows Dr. Schulte's apparatus and how it is used during the test



Blazing the Trail for Polar Airlines

Daring Explorer Attempts to Fly 2000 Miles across Frozen Arctic in One Jump; May Shorten Travel Routes

THE whole world this summer is watching with interest the daring attempt of Capt. Roald Amundsen to fly 2000 miles across the frozen wastes of the North Pole without a stop.

If the famous explorer succeeds in jumping by airplane from Point Barrow, Alaska, to the island of Spitzbergen, just north of the Scandinavian peninsula, he will have opened up an Arctic airline that will shorten transportation distances from North American cities to Europe and Asia by thousands of miles.

While flying experts are predicting an era in which travel by air will be as commonplace as travel by water or land is at present, it remains to be seen whether airships will be able to use the shortest routes between various points on the globe or whether they will be obliged to follow the longer routes in the temperate zones. Should Amundsen be able to jump from the eastern to the western hemisphere over the top of the world through a land of ice and snow, where a forced landing means almost certain death, the problem will be solved.

Here is the giant monoplane in which Capt. Roald Amundsen (standing in the center of the picture) is attempting a 2000-mile non-stop flight this summer over the North Pole, from Point Barrow, Alaska, to the island of Spitzbergen. The map of the top of the world, above, shows how transportation distances between the world's great cities will be cut if the establishment of arctic commercial airlines is proved by Amundsen to be practical

At this writing Captain Amundsen was reported proceeding by dog sled from Nome, Alaska, to his base of departure at Point Barrow. His plan was to make use of the summer solstice, when the sun shines 24 hours a day in the arctic regions. He expected to hop off on his non-stop journey some time between June 20 and 28.

In the 2000 miles between Point Barrow and Spitzbergen lies a territory covered with glaciers 3000 feet deep. Between Spitzbergen and the northern coast of Siberia is a vast area that never has been explored. While Amundsen's immediate purpose is to explore this region, the successful termination of his flight is expected to have far greater results commercially.

By the arctic route, the traveling distance from San Francisco to Petrograd, Russia, which now is accomplished by way of New York and across the Atlantic Ocean, would be reduced to 5300 miles—a short cut of 2200 miles. In making the journey, the longest single jump through the polar region would be 2000 miles, as compared with the 3000-mile distance by water from New York to Europe.

The success of polar flight will bring all of the world's great cities closer together commercially. While at first glance it might seem shorter from San Francisco to Cairo, Egypt, across the Pacific Ocean, actually 1500 miles would be cut from the journey by crossing the arctic regions.

The newly discovered goldfields of northern Siberia would be 2400 miles nearer New York than at present. Amazing progress in the science of aviation may make it possible to tap this rich territory that now lies practically idle because of its inaccessibility.

The shortest air route from London to Tokio is at present 6300 miles. A thousand miles could be cut from this tedious journey if an airplane line were established over the North Pole. Similarly, the distance from Chicago to Archangel, the most northerly port of Russia, could be shortened by at least 1200 miles. Archangel is closed completely for a large part of the year because of ice. The airplane can keep Russia's only western seaport open the year around.

Looking into the future, aviation experts are confident that towns in the polar region eventually will develop into great centers of air transportation rivaling in importance the world's leading shipping ports of today. The inhabitable shores of Greenland, the northern coasts of Alaska and Siberia, as well as such islands as Spitzbergen and Wrangel, may soon become busy halfway stations for intercontinental air lines.

DO YOU suffer from hay fever? One out of every 100 Americans do, and yet some people think it is a joke.

William M. Patterson, chairman of the executive committee of the United States Hay Fever Association, has prepared an unusually informative and helpful article on this important subject for the August issue of POPULAR SCIENCE MONTHLY.

Coast-to-Coast Air Mail—28 Hours!

Record Non-Stop Flight Hastens Day and Night Postal Service

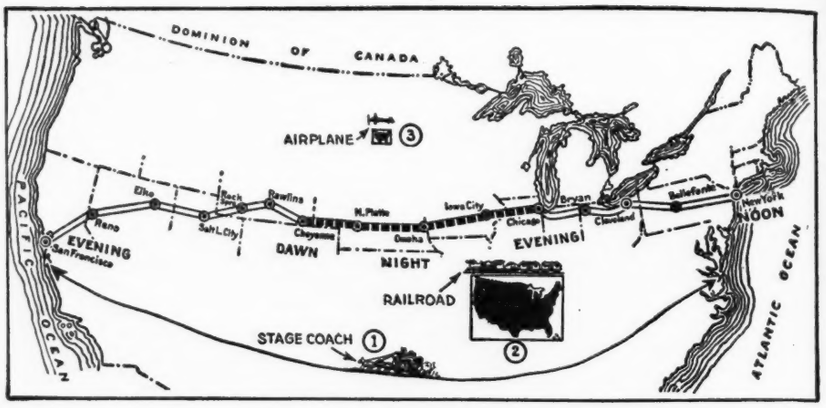
By Norman C. McCloud

LETTERS mailed at New York at noon, delivered in San Francisco the next evening!

When the two army fliers, Lieuts. Oakley G. Kelly and John A. Macready, recently landed at Rockwell Field, San Diego, Calif., completing a non-stop transcontinental airplane flight of 2600 miles from Hempstead, N. Y., they did more than establish a new world long-distance record. They did even more than herald a new epoch of long-distance commercial transportation by air.

By piloting the four-ton army monoplane T-2 from ocean to ocean in 26 hours and 50 minutes, they proved conclusively that all-night air transportation over land is entirely practical. And in so doing, they proved the immediate feasibility of Uncle Sam's plans for the establishment of transcontinental air mail service on a definite schedule of 28 hours, as had been predicted by Brig. Gen. William Mitchell, assistant chief of the Army Air Service.

Viewed simply as a sport contest, the feat of Lieutenants Kelly and Macready is a spectacular triumph for American aviation, which now holds the world's records for altitude, speed, distance, and sustained flight. But its real significance lies in its commercial value. Figuratively, they have shrunk the United States until, viewed in the light of transportation distances, it is a mere township in size compared with the United States of stage-coach days, and one sixteenth the size of the United States of fast mail trains.



THIS map shows the route of Uncle Sam's projected 28-hour, day-and-night airplane mail service from New York to San Francisco. The dark portion shows territory to be covered at night. Circles indicate terminal stations, while white bands represent emergency fields. The small maps show how the United States has shrunk in transportation size since the olden days of the stage coach

Beacons Guide Fliers

In the black of night, while the 250-horsepower Liberty motor hummed along without faltering, these two army airmen guided their plane above a maze of confusing lights below them, by means of prearranged flares. Thus they proved the soundness of the government's plans for lighthouses, established at intervals across the continent to guide air mail fliers.

And so, with full assurances of success, Uncle Sam is now completing preparations for the establishment of day-and-night scheduled air mail service between New York and San Francisco. This service probably will be established before the close of the summer.

Leaving New York at noon the mail planes are scheduled to reach Chicago, Ill., in the evening; Omaha, Neb., at midnight; Cheyenne, Wyo., at dawn, and San Francisco toward evening of the second day. This schedule calls for about 1000 miles of night flying, the total time from coast to coast being 28 hours.

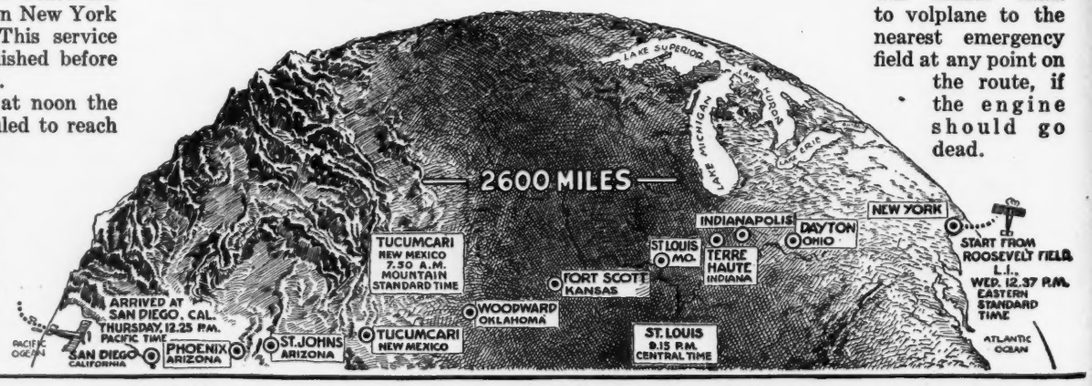
The pilots will be guided by a pathway of powerful beacons pointing the way to terminal fields. In addition, emergency fields will be lighted every 25 miles along the route. As a result, millions of people in the Middle West nightly will witness an artificial aurora borealis that will be visible for 50 miles from the five nighttime terminal fields, at Chicago, Iowa City, Omaha, North Platte, and Cheyenne. The beacons at these fields each will have 600,000,000 candlepower. The light will swing around three degrees above the horizon, throwing a strong beam at the rate of three revolutions a minute. The smaller beacons at emergency fields will throw a light of less intensity in a circle. They will be visible for 30 miles.

Lieutenant Macready (above) and Kelly (below) with the army monoplane T-2 in which they made their record non-stop transcontinental flight. Lieutenant Kelly is shown standing beside the machine

Sky Traffic Lights

As a final safeguard, flashing traffic lights, like those on city streets, but directed toward the skies, will be located every three miles along the line of flight. Thus on a clear night, the air mail pilot 7000 feet up will see a narrow line of light stretching for miles over level prairies.

It is estimated that the pilots will ordinarily fly at an altitude that will enable them to volplane to the nearest emergency field at any point on the route, if the engine should go dead.



Cities along the 2600-mile route covered by Lieutenants Kelly and Macready in their transcontinental non-stop flight are indicated above. The official time from Hempstead, N. Y. to San Diego, Calif., was 26 hours, 50 minutes

Checking Up on Einstein

Remarkable Eclipse Photographs Prove that Light Rays from Stars Are Bent by the Sun's Influence

Dr. Albert Einstein

By Henry Dunham

"AN EPOCH-MAKING event," is the way scientists are characterizing the announcement of Dr. W. W. Campbell, director of the University of California Lick Observatory, that he has succeeded in confirming conclusively Dr. Albert Einstein's revolutionary theory of relativity. Doctor Campbell's proof, according to his announcement, is based on the study of photographs of the eclipse of the sun taken at Wallal on the northwest coast of Australia, Sept. 21, 1922, by the W. H. Crocker eclipse expedition from the Lick observatory, Mount Hamilton, Calif.

Star's Rays Bent by Sun

The results of these photographic observations, Doctor Campbell says, are in exact accordance with the requirement of the Einstein theory that light has weight, and that therefore in passing from the farther stars to the earth it is bent from a straight course by the gravitational attraction of the sun. In other words, that the positions our astronomers have given to the stars are not their *true* positions in the heavens, but only their *apparent* positions based on the supposition, perhaps erroneous, that their light always travels to us in straight lines.

Several years ago Einstein announced that his theory of relativity must stand three astronomical tests successfully, or be revised. One of these tests was the eclipse problem, which Doctor Campbell now claims to have completed.

"If astronomers photograph the stars surrounding the sun at time of total eclipse," said Einstein in substance, "they will find that the image of a star whose ray, in traveling from the star to the photographic plate, just grazes the edge of the sun, will be displaced outwardly from the center of the sun's image a distance of 1.75 seconds of an arc. The star's light ray will be bent from a straight line by this amount while the ray is passing through the sun's gravitational field."

Careful measurements by Doctor Campbell and by Dr. Robert Trumpler, an associate at the Lick Observatory on Mount Hamilton, showed the average deflection of stellar rays on the Wallal eclipse photographic plates to be 1.74 seconds of an arc. "This," says Doctor Campbell, "is as close to Einstein's requirements as the most ardent proponent of his theory could hope for."

The important corollary of this discovery, astronomers tell us, is that if rays of light are bent and twisted out of their supposedly straight courses by the attraction of the sun, then the rays probably are bent in the same way by other planets, including our earth, when the rays pass close enough to come within gravitational influence. This being true, we are told, it is equally probable that our entire conception of the universe, its construction and operation and the position of stars and planets in it, is erroneous. It is erroneous because we have been seeing celestial bodies in positions that they do not actually occupy.

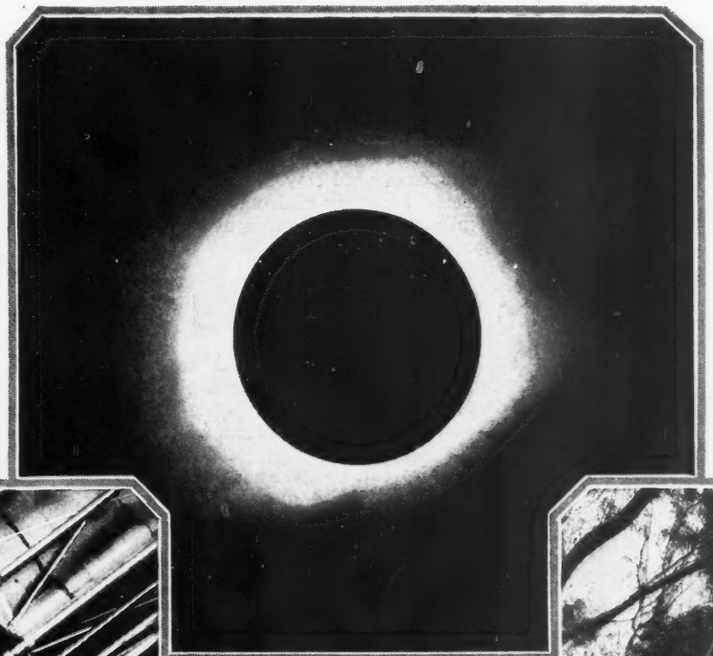
The story of how Einstein and his theory were checked, of how the eclipse photographs were obtained and measured, constitutes one of the most remarkable achievements of modern science.

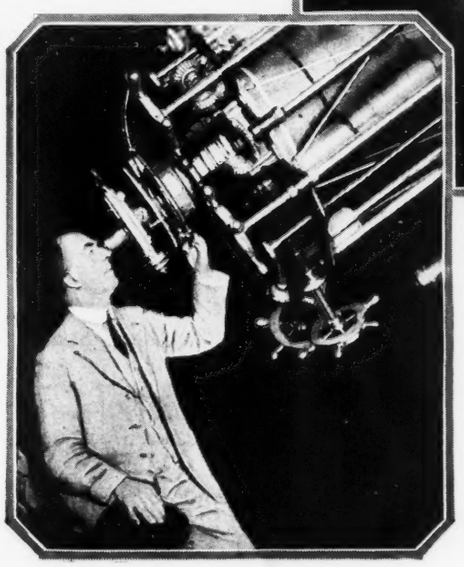
How the Photographs Were Made

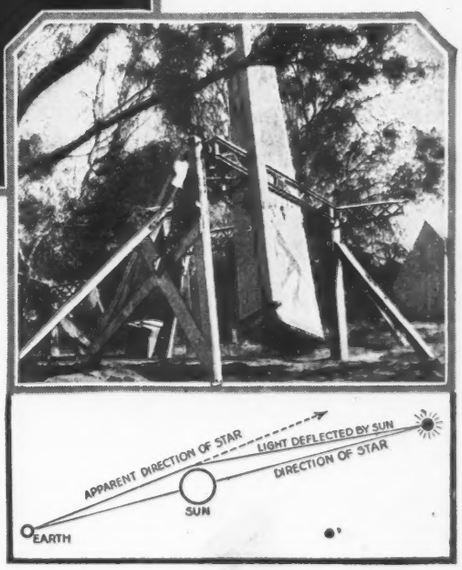
Obviously, it was impossible for scientists to photograph stars beyond the sun while the sun was shining in the day sky. The only time the stars could be photographed in the daytime was during a total eclipse of the sun. Such an eclipse, visible most clearly from the northwestern coast of Australia, occurred on Sept. 21, 1922.

In order to expose four photographic plates of the stars beyond the sun while this five-minute eclipse was darkening the sun, the Crocker Astronomical Expedition headed by Doctor Campbell, traveled 16,000 miles to Wallal in an isolated section on the Australian coast. The photographs were made by a huge camera with a lens five inches in diameter and a focal length of 15 feet, using plates 17 inches square.

Previously, Doctor Trumpler had gone to the island of Tahiti, and there had made nighttime photographs of the same stars. With these nighttime negatives, the eclipse photographs later were compared. After careful measurement, the exact amount of deflection of the stars' rays by gravitational influence of the sun was determined.







Above, total eclipse of the sun which enabled the expedition of astronomers led by Dr. W. W. Campbell, director of the Lick Observatory, to make daytime photographs of stars beyond the sun and so confirm the Einstein theory. At the right is the huge telescopic camera used in making the photographs at Wallal, Australia.

At the left, Doctor Campbell at the great Lick telescope.

The diagram shows, in an exaggerated way, the Einstein theory that light rays from a distant star are bent by gravitational influence of the sun, making the star appear to us in a position that is false

Pendulum Camera for Movies at Sea

THIS remarkable cinema photograph of a thrilling episode in the life of whale hunters was made recently for the film production, "Down to the Sea in Ships," by means of the newly invented pendulum camera at the right.

Heretofore the effectiveness of movie scenes photographed at sea has been marred by the exaggerated swaying motion of objects when reproduced on the screen. This has been caused by the rocking motion of the camera as the boat supporting it pitches about in the heavy seas.

The new camera is equipped with an ingenious ball-and-socket device that keeps the camera level, no matter how much the photographers' boat rolls and pitches.

The camera is mounted on the ball of the universal joint. Weighted underneath, this ball rests in the socket supported by the camera tripod. Thus the camera tends to remain stationary while the tripod follows the movements of the boat.

Use of Iron Ore Cuts Cost of Roadbuilding

IRON ore, which is plentiful in northwestern Louisiana, is being used successfully in roadbuilding by highway engineers of that state. The ore is used as a binder in place of sand clay, and is said to have effected a saving of from $2000 to $3000 a mile in the cost of construction for the taxpayers of Louisiana.

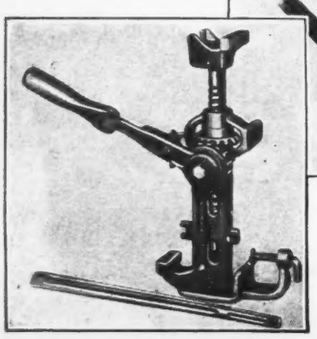
Auto Jack Serves as Vise or Drill

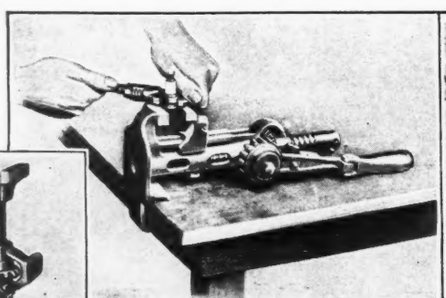
COMBINING several handy tools in one, a novel utility jack has been designed especially for use on the long automobile trip or in camp. It will serve many purposes also about the house or garage.

By means of a clamp at its base, the jack may be fastened firmly to the automobile runningboard or to a workbench, where it serves as a vise. The jaws of the vise are operated by moving the gear handle of the jack.

The device can be transformed quickly into a boring machine for wood, simply by turning it upside down, removing the head, and inserting a bit in the end of the jackscrew. In this position the swiveled handle is bent to form a turning crank.

The jack also can be used as a ratchet drill for drilling in close quarters; as a breast drill for drilling in iron, tapping, reaming, and countersinking.

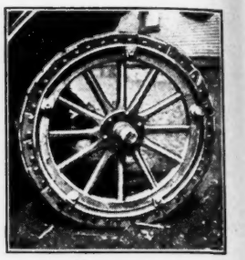




Fastened to the workbench by means of a clamp, this novel auto jack serves as a vise, as shown above. The handle operates the jaws of the vise

Used as a wood boring machine

Emergency Auto Tire of Wooden Blocks



AN EMERGENCY automobile tire, consisting of a chain of wooden blocks that may be attached to the rim with iron clamps, has been patented by Benjamin C. Gochenouer of Spokane, Wash. It is designed to replace a blown-out or punctured tire, allowing the owner to drive his car home without injury to the rim.

Side-Hill Stepladder Is Self Adjusting

A SIDE-HILL stepladder that will stand with its steps level on a stairway or on the slope of an embankment, has been invented by Weaver Martin of Lafayette, Ore.

An extensible support, consisting of a metal arm, is attached to one of the stand-

How the stepladder adjusts itself to the steep slope of an embankment

ards. The arm slides and can be adjusted, by means of a series of holes and a locking pin, with an extension that is fastened to a transverse bar pivoted to the bottom rung of the ladder. The pivot allows adjustment to any angle. The angle iron extension bar is bored with a series of holes.

The back support of the ladder is in one piece so it can adapt itself to any plane.

The Science of Bathing

DO YOU know the right way to take a bath?

An eminent physician is preparing an unusual article on this subject for next month's issue of POPULAR SCIENCE MONTHLY. He will describe the bathtub route to health and offer sound advice for summer bathing.

New York City'. $70,000,000-a-year nighttime display. Hydroelectric power would produce as much light, it is claimed, at one tenth the cost

Rivers of Cheaper Light and Heat

By T. Kennard Thomson
Noted Consulting Engineer

SCIENCE is about to open the door that will release from the waterpower resources of the country 80,000,000 horsepower of energy, enough to heat and light the homes and turn the wheels of the nation.

One obstacle only stands in the way of utilizing the tremendous power flowing in our rivers—that is the lack of a practical means of transmitting electric current at high voltage for long distances.

Already current has been transmitted for a short distance at 1,000,000 volts. Dr. Charles P. Steinmetz, electrical wizard, did it recently in an experiment. He predicts that the same feat soon will be commercially practical.

When electrical power can be carried long distances without waste, engineers say, the power problem of the nation will have been solved. Coal famines will be unknown because coal will cease to be the important factor in the production of power.

The total water-power resources of the United States have been estimated at 80,000,000 horsepower, the equivalent of 800,000,000 tons of coal a year, or 200,000,000 tons more than the total amount of coal mined in the country annually. Thus it is apparent that water alone can supply our power needs for years to come.

At present, current is carried several hundred miles at a voltage of 250,000.

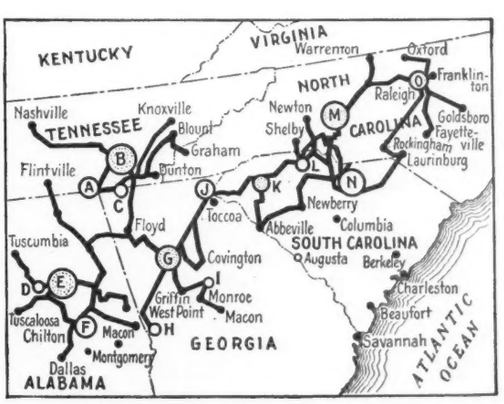
When it can be carried 2000 miles at a voltage of 1,000,000, the scattered hydroelectric plants that now serve local needs can be hooked up in one huge power project and, with new plants to be erected, can put to commercial use all the water power in America.

This plan of connecting individual plants in series already has been adopted on a fairly large scale in a group of Southern states. A single system more than 600 miles long covers the more important industrial areas of Alabama, Georgia, Tennessee, South Carolina, and North Carolina. California has a similar system and New York state engineers are working along the same line.

To grasp the economic possibilities of this development, consider the cost of water power as compared with coal.

A plant designed to utilize one half the water flowing over Niagara Falls is expected to produce at $15 a horsepower. It takes 10 tons of coal to produce one horsepower. Coal at present costs about $14 a ton. Therefore water power at the Niagara plant will cost only about one tenth as much as coal power.

Electricity at $15 a horsepower represents a cost of one quarter cent the kilowatt hour. That is, 20 ordinary electric lights burning for one hour would cost only one fourth of a cent. Compare this with what you pay at present for lighting your home and you will see what a decrease in light bills may be achieved by use of "white coal."



How isolated hydroelectric power plants have been linked successfully into one 600-mile power system to serve an entire group of Southern states. Letters indicate location of plants

Next in importance to cost is the utilitarian value of inexpensive power.

With cheaper electricity will come a more general use of household electrical appliances for heating and lighting purposes. Manufacturing and transportation facilities will be increased; farming will become more profitable; the cost of living will be lowered; health will be improved by the elimination of the smoke nuisance. Traffic congestion will be relieved and coal famines will be things of the past.

The greatest single source of power in the United States and the one that probably will be the first to be fully developed is Niagara Falls. That part to be utilized is capable of producing 4,000,000 horsepower. The St. Lawrence River probably will be next in line to receive the attention of engineers. It will produce another 4,000,000 horsepower. Radiating from the Great Lakes section will be thousands of miles of electric lines delivering power to distant parts of the United States.

After the larger power sites have been fully developed, engineers will turn their attention to the lesser rivers.

While geologists tell us that coal will last for 4000 years, it must be remembered that the price increases for every foot we descend into the earth to reach it. With the coming of water power on a large scale, coal seems economically doomed as the principal energy generator.

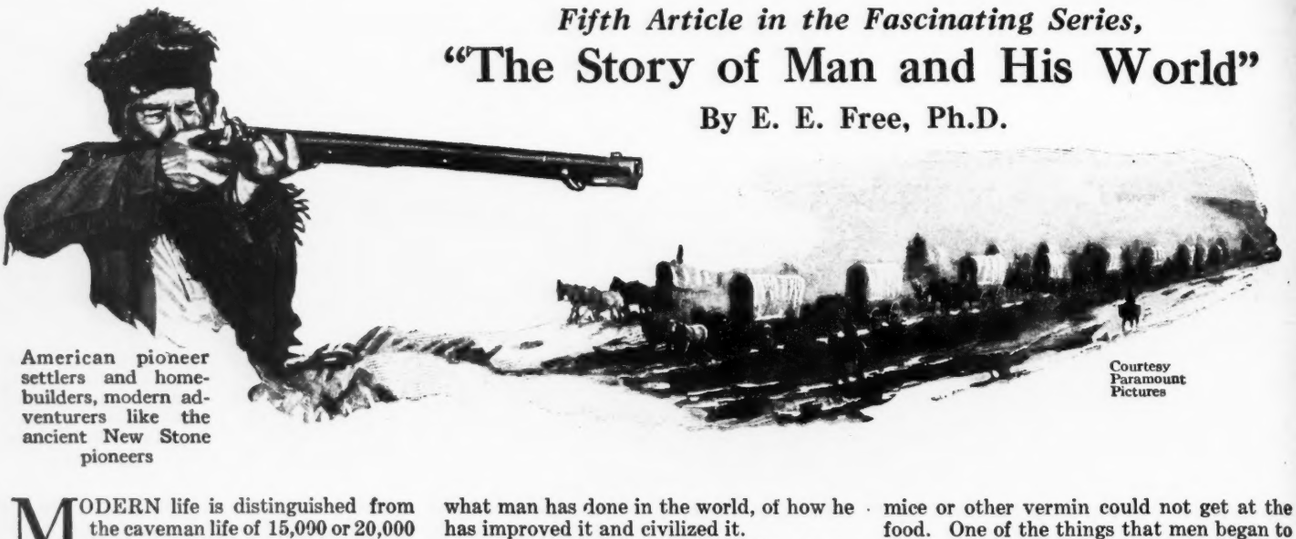
PIONEER CAVEMEN WHO

How Our Ancestors Gathered Knowledge by Cooperation

Fifth Article in the Fascinating Series,

"The Story of Man and His World"

By E. E. Free, Ph.D.



American pioneer settlers and home-builders, modern adventurers like the ancient New Stone pioneers

Courtesy Paramount Pictures

MODERN life is distinguished from the caveman life of 15,000 or 20,000 years ago by the thing called civilization.

So far as we can determine from the remains that have come down to us, the cavemen were about as clever and inventive and artistic as we are. Their brains seem to have been quite as intelligent as ours. Their bodies, as the result of a more healthful outdoor life, were probably better than ours.

We are better off than these ancient ancestors of ours, not because we have improved *ourselves*, but because we have improved our world. The substance of this improvement is present-day civilization.

Up to this point in our story of man and his world we have been tracing the origin of life itself and of the human animal. We have considered the probable beginnings of the earth and we have seen how life itself may have begun in the first specks of living matter in the primeval sea. We have traced the descendants of these living specks through a billion years of evolution until they led, at last, to man.

We must turn now from this story of the origin of man to the still greater story of what man has done in the world, of how he has improved it and civilized it.

Civilization might be defined in a hundred different ways, but the essential thing about it is, I think, the gradual accumulation of knowledge. Let us consider, for instance, how man probably invented agriculture.

The first men, like the apes who had preceded them, merely gathered their food from the free bounty of nature. They hunted for and found those fruits and nuts and grainlike seeds that grew naturally in the forest or near to it, just as modern boys still hunt for sassafras or beechnuts. It never occurred to these primitive men that they could plant seeds on purpose and thus secure more grain. They did not even know what seeds were, nor that new plants would grow from them if they were put into the ground.

But finally, not more than 20,000 or 25,000 years ago, men began to notice things about these familiar grain plants from which they gathered edible seeds in the autumn. In those days the winter stores of grain and the like were kept, we believe, on raised covered platforms, like little huts on stilts, where dampness and mice or other vermin could not get at the food. One of the things that men began to notice was, perhaps, that underneath one of these raised granaries where grain had been stored during the winter, it was usual for a lot of new grain plants to grow up the next spring.

No one realized, at first, that this was due merely to accidentally scattered seed. They did not know, you remember, anything about seeds. That new growth of grain close to where the old grain had been was a mystery similar to the hundreds of other mysteries with which primitive man felt himself to be surrounded.

The intelligent and serious minded men of those times pondered this mystery of the grain, we may be sure, for years, perhaps for generations, just as modern scientists ponder the remaining

The Constant Climb of Civilization

Our artist's conception of how man has risen in less than 20,000 years from the savagery of the New Stone Age to civilization and the mastery of his world

IN THE beginning, men hunted and fought. Each man lived for himself. Every other man was his enemy. Gradually men gathered into groups. They built villages, some of them like the Swiss lake village of the New Stone Age shown at the extreme left. In Babylonia, men founded cities and built great temple towers to honor their gods.

Throughout the ages men have built empires and civilized communities. Then, fighting each other, they have torn down everything that had been built. How long will this go on?

Modern men turned to the conquest of nature. The soldier has given place to the workman and the engineer. Will we fall again to fighting and tear down the civilization we have built?

INVENTED CIVILIZATION

natural mysteries, such as electricity and gravitation. Finally, some forgotten prehistoric genius thought of the right answer. He understood that the old seed and the new plant were related. The way lay open, then, for the artificial planting of grain, the increase of the food supply, and the gradual perfection of the tillage of the soil, which is one of the chief props of modern civilization.

Men Begin to Work in Groups

The point of this story is that the beginning of agriculture was the discovery of the fact that plants grow from seed. After this came the discovery of other facts: facts about how and when to plant the seed; facts about what kinds of seed were best to plant, facts about what kind of soil to use and how to prepare and tend it. Agriculture, even today, is no more than the practical application of facts like these that man has learned.

The other arts of civilized man rest upon a precisely similar basis. The making of steel knives and of steel buildings rests upon facts learned gradually, just as agriculture was learned; facts about how to get iron from the ore, about how to purify and melt and shape it. Clothing, houses, tools and weapons, the modern profusion

of machines, all depend entirely upon this same process of the slow accumulation of knowledge. That is what civilization is.

It is important to remember, however, that the *cause* of civilization is not the mere possession of agriculture or fire or metals or machines. It is not even what we call discovery or invention. The real cause of it, the cause of all the progress that the world has managed to accomplish, is quite a different thing. It is the fact that discoveries and inventions have been *remembered*.

This remembering of things is a racial matter, a cooperative matter. One man, all by himself, could never have produced a civilization. Even if he had succeeded, by some miracle, in producing it, it would have perished when he died. The progress of the world has gone on because men have worked together as members of the larger whole that we call mankind. Men working singly, as individuals, would have accomplished nothing.

Think, for example, of a great modern corporation. The policy of such a corporation, the ideals of its founders, its processes and secrets, its accumulated knowledge of materials and markets and trade movements, may go on for generations. What one set of its officers learns is passed on to their successors. Men die. The corporation does not.

Civilization began and has continued because society, embodied in the tribe, the nation, the group of states or nations, has worked just as a corporation does. Imagine, for instance, a primitive man who has become unusually expert in that greatest and most important of prehistoric arts, the making of good knives and arrowheads out of stone. This art required both great knowledge and great skill of hand; knowledge of just what kind of stone to use and of how to chip it into shape, skill in applying exactly the proper pressure at exactly the right point in order to flake off just enough of the stone and not too much of it.

A man skilful at this was a great asset to any tribe or family in the prehistoric world. As long as he was alive, the tribe had better weapons than their neighbors. But suppose he died?

Men discovered, after a while, that such skill should not be allowed to die with its possessor. So they invented the idea of apprenticeship. A promising boy was assigned to help the skilled stoneworker. Gradually the boy acquired some of the skill and knowledge of the older man. In time the old man died, but there was no loss to the tribe. His skill went on in the person of his youthful pupil.

Cooperation the Key to Civilization

This same sequence of events applied to other arts, and applied generally to everything in life, will give you the clue to the cause and essence of civilization. It requires, you notice, that men should live more or less permanently together, that the children should be kept permanently with the tribe or family group, not kicked out as soon as they are old enough to shift for themselves.

That is what civilization really is: the cooperation between a fair number of men and the permanence of this cooperation through more than one generation. The invention of this system, not the invention of fire or of agriculture or of metals or of any other material thing, is what we must call the invention of civilization.

The men who invented this kind of cooperation were, so far as we can determine, the men of the age that scientists call the Neolithic—the Age of New Stone.

At the end of the last chapter we saw how the men of this New Stone Age were beginning to come into Europe 10,000 or 12,000 years ago as wanderers out of Asia. Men of the same sort had already founded, as we shall see presently, the ancient civilizations of Egypt and of Babylon. Other waves of these same men had moved eastward instead of westward and were to found, a little later, the ancient civilization of China.

Fathers of the Modern World

It is probable, even, that some of these same New Stone Men crossed the Pacific by way of Siberia and Alaska and that their descendants, centuries later, produced the ancient American civilizations of the Mayas and of Peru. There is little doubt that when we come to know better what went on in the thousands of years before written history began, we shall be able to trace the beginnings of every known civilization, past and present, to these same men of the New Stone Age.

This is a very significant fact. The reason for it is that these New Stone Men, in the thousands of years before they moved into Europe, had invented cooperation. They knew how to work together. The New Stone arrow-maker taught his skill to boys and left it behind him for the progress of mankind. The tribal communities of the New Stone Age were continuous communities, like corporations. Nothing useful was lost.

The artist-hunters of the Old Stone Age who had held Europe for so long before the New Stone men arrived, do not seem to have known anything about this great invention of the cooperative community. That is why they never invented any real civilization.

In these earlier Old Stone times, 15,000 or 20,000 years ago, Europe was in the last stages of the Great Ice Age. It was a coun-

try of chilly, treeless plains a good deal like Siberia or northern Canada today. Herds of reindeer and of wild ponies wandered over the plains. The Old Stone men lived on these herds. The bodies of the animals supplied food and their skins supplied clothing. The men of the Old Stone Age depended on the herds of ponies and of reindeer much as the Indians of the Western plains depended, centuries later, on the herds of buffalo.

A life like this did not encourage cooperation or the formation of communities. It was a roaming life. The herds of animals were always moving and man had to stick close to them or he would starve. A whole tribe would scare the herd away or exterminate it. It was better that no more than two or three people should live together.

The Old Stone Men Overcome

This age of scattered hunters, hanging, two or three together, on the flanks of the grazing herds, lasted in Europe for perhaps 10,000 or 12,000 or more years. Its most flourishing times, the times of the best cave paintings and the skillful making of stone tools, was about 16,000 years ago. At the same time the New Stone men who were to supplant them were developing cooperation elsewhere, perhaps in Asia.

And then, gradually, there came a change. The Great Ice Age was ending. Europe was growing warmer. Forests began to spring up on the grasslands, and the herds, which could not graze on forest lands, grew sparser and moved north where the country was still too cold for trees. The Old Stone men who had lived so long and safely on the produce of the herds faced the ruin of their world, just as the Indians, long afterward, were to face extinction when the introduction of firearms began to exterminate the buffalo.

This was about 12,000 years ago, and it was then that the men of the New Stone Age began to come from Asia.

They came into a population already weakened by the loss of their traditional food supply, a population that already had been forced to change, as their tools and weapons show, from a race of hunters into a people who eked out a bare existence by spearing fish in the streams.

New Stone Men Used Better Tools

This may have made the conquest easier for the New Stone invaders, but they would have won anyway. They had agriculture and domestic animals and better kinds of tools.

Scientists are accustomed to distinguish the remains of these two contrasted ages—the Age of Old Stone and the Age of New Stone—by certain differences in the stone tools that were made in the two periods. The New Stone tools are smoothed and polished. The tools of the Old Stone men are merely chipped, though many of them have efficient shapes and razor-like edges.

From the viewpoint of an historian of civilization, this difference in the tools is not the important difference. The important one is that the New Stone men used pots made of baked clay, the same kind of pots that were made by the Indians of the American Southwest until a few years ago.

This fact—the beginning of the use of pottery—is probably the most important landmark in human history. If we knew in just what year men first used pots to cook in, we ought to date our era from that year.

Courtesy Metropolitan Museum of Art

Ancient statuette of a slave girl of Egypt, one of the world's first three civilizations

It marked the end of Man the Cunning Animal; the beginning of Man the Master of the World.

This was not, of course, because of any magic virtue in the mere possession of a cooking pot. The pot is merely a piece of evidence. It is important because it proves that man had invented cooperation and communities, that he had begun to have a home.

Why does pottery prove this? Because pots are breakable. A wandering population has no use for them. The homeless hunters of the Old Stone Age would have smashed pots faster than they could make them. When we find that the New Stone Men had pots and plenty of them, we know that their wandering days were already over, that they had made the first great invention of the beginning of civilization, the invention of a permanent home in which a number of people could live together and begin the cooperative accumulation of knowledge.

The first pots are found among the relics of the New Stone Age. There we find also the first evidence of agriculture, the first use of domestic animals (except, doubtfully, the hunting dog), the first weaving of textiles, the first indications of huts or houses of any kind.

New Stone Traces in Persia

This is why we feel so sure that we must credit to these New Stone people the making of that original invention that made all others possible—the invention of cooperation and of community life.

The earliest remains of this New Stone Age that was to prove such an important landmark in human history have been found, not in Europe, but underneath the ruins of the ancient city of Susa in what is now the southwestern part of Persia. One hundred and thirty feet under the surface of the rubbish heaps that mark the ruins of this city, modern diggers found the relics of the New Stone Men. Under this was virgin soil. The people of the New Stone Age were evidently the first inhabitants of the site of Susa and investigators believe that they settled there more than 8,000 years ago.

This is much earlier, you notice, than any remains of the New Stone Age in Europe. At that time the men of the Old Stone Age in Europe had not begun to decline. In fact, they had not yet reached their best and most artistic age. At least 6000 years were to pass before people like those who settled in Susa were to appear in Italy or France.

Human Progress Flourishes in Asia

This makes it evident that the clock of human progress ran faster in Asia than elsewhere in the world. The great invention of the community, the discovery of agriculture, the taming of domestic animals, the production of pottery, all were accomplished somewhere in Asia, perhaps in the neighborhood of Susa itself, 6000 or 8000 years before Europe experienced them at all. When these essentials of civilization came into Europe, they were brought by invaders from the east.

These invaders must not be thought of as a marching army nor as of any single race. They seeped into Europe gradually. They permeated rather than conquered it.

What happened must have been a great deal like the situation of 70 or 80 years ago in the American West, when the farmers were beginning to push out there. The only white men who were already in this western country were hunters and trappers. Most of them were solitary men. They moved around to follow the game. They attempted no agriculture. They had almost as few

possessions as their ancient European prototypes, the men of the Old Stone Age.

Then the farmers began to come into the country. They were of no different race from the trappers who were already there, but they had a different outlook on life. They were men with homes. They brought their oxen and their plows. Their wives and children rode with them across the plains in long trains of covered wagons. These men were "settlers." They meant to settle down in one place and stay there, just as their European brothers of the New Stone Age had done so many centuries before. Gradually they pushed the wandering hunters altogether out of the country.

The Difference in Knowledge

In just about this way, we may imagine, the New Stone men supplanted the Old Stone men in Europe. They were not conquerors or invaders in the military sense. They were not aliens. The men of both periods were of mixed races and apparently of the same races, just as the American emigrants, hunters and farmers alike, were mixed and were similar.

The difference in favor of the New Stone men was a difference in knowledge. They had begun to accumulate a stock of common knowledge. They possessed the essentials of civilization. The Old Stone men did not.

But meanwhile, on their way to Europe, some of the New Stone emigrants had stopped off and started communities, much as some of the westward settlers of the forties stopped off at Kansas City or at Omaha and founded cities of their own. One group had entered the fertile valley of the Nile. Another group had settled in the plains of Babylonia. A third group had discovered the island of Crete in the Mediterranean Sea.

All three of these groups developed local centers of civilization. By 4000 or 4500 B.C., there were kings and governments and writing and the beginnings of science in both Egypt and Babylonia and the development of Crete was not more than 500 or 600 years behind.

The Oldest Race?

And here is the important point: Underneath the ruins of all three of these ancient civilizations, at the very bottom of the scores of feet of rubbish accumulated during the 6000 years of recorded history, we find the flint knives and the broken pottery of the New Stone Age.

The men who founded Susa were men of the same habits and culture as those who founded Crete and Babylon and Egypt. They were, indeed, the men who founded everything. They brought into these ancient lands the seeds of progress and of greatness just as surely as they brought into Europe, when they reached it, the seeds of barley and of wheat.

These men of the New Stone Age, not the Greeks nor the Romans nor the Nordics, were the real founders of the modern world.

In the beginning, the three ancient civilizations of Egypt, Crete, and Babylon were not importantly in contact with one another. There was little mutual effect on one another's development. But about 2300 B.C. the ancient world seems to have entered upon a period of great prosperity and industrial expansion. The traders of Babylonia began to make frequent visits to Crete and Egypt. An active commerce sprang up around the coasts of the Mediterranean. The three streams of growing civilization that had risen separately in the three countries out of the same New Stone source, were reunited, never to be divided again.

From that time to the present day the story of the world lies in the province of the historian, not of the scientist. Some of the features of this story—the discovery and subjugation of metals, the providing of mechanical power to replace slaves, the development of writing, the scientific study and improvement of agriculture—we shall need to consider in later articles.

But these are incidentals. The main fact is that by 2000 B.C. man had his feet on the path that he has followed ever since. He had been through the furnaces and forges of his animal ancestry and his body was as perfect as it is today; as perfect, probably, as it ever will be. His mind had taken on its present mold. He had learned how to cooperate with his fellow men, and he had invented communities and homes.

Man was ready in those ancient days, 40 centuries ago, to begin his greatest adven-

(*Turn to page 96*)

Our artist's conception of an ancient temple tower, center of civilization in early Babylon—probably the original Tower of Babel

Largest Oil Tank Covers 20 Acres

Bird's-eye view of the world's largest oil tank at Wilmington, Calif. The capacity of the tank is 1,750,000 barrels of oil

COVERING an area of 20 acres and with a capacity of 1,750,000 barrels, the world's largest oil storage tank is nearing completion at Wilmington, Calif. The concrete tank will rise only eight feet above the ground, half of it being below the surface. The roof will be supported by wooden poles set in concrete blocks in the bottom of the tank, also of concrete.

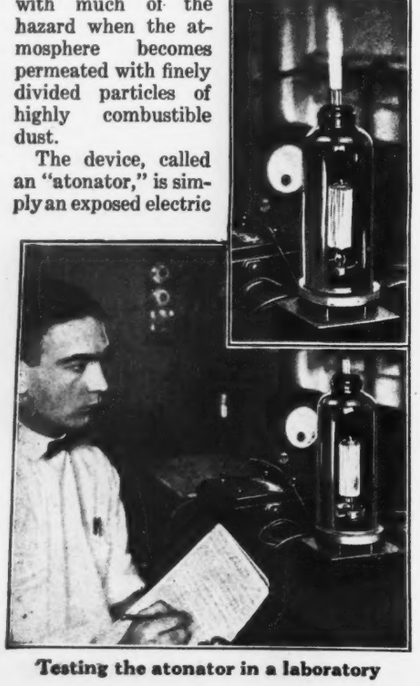
Despite the vast quantity of oil that will be held in the tank, the sides and bottom will be only four inches thick. This feature is made possible by the careful preparation of the earth under the tank, by the methods of reinforcing the concrete and by the nature of the concrete. All soil around the excavation for the tank within accurately determined distances is removed and repacked until it is much more dense than at first. This is accomplished by tractors treaded with iron attachments that resemble a sheep's hoof. The sides of the excavation are packed beyond the limits to which the side of the tank will extend. These sides are then cut through so that at all places the texture of the soil will be constant.

This mammoth tank is the only large concrete project of its kind built of poured concrete; usually they are constructed of steel.

Filament Prevents Dust Explosions

SEEKING to eliminate dangerous dust explosions in mines, flour mills, and other industrial plants, scientists recently have succeeded in developing a device that promises to do away with much of the hazard when the atmosphere becomes permeated with finely divided particles of highly combustible dust.

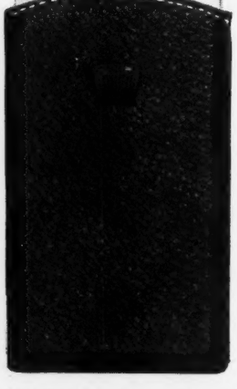
The device, called an "atonator," is simply an exposed electric light filament covered with porcelain. The glowing porcelain, heated by the filament, burns up gases and inflammable dust so fast that they cannot accumulate to cause explosions.



Testing the atonator in a laboratory

Pull the Ribbon and up Comes Your Card

A HANDY little cardcase that keeps the cards clean and gives them up at the pull of a ribbon, has been invented recently by a Chicago firm. It lies flat in the pocket, has no metal parts, flaps, or buttons, and is made of flexible leather.



A ribbon fastened at the back runs under the cards and comes out at front near the top. When a card is wanted just pull the ribbon. The cards come up. When pushed down, the ribbon runs back in its slot, leaving only the end sticking out, as illustrated above.

Stop and Go Signal Lights for Trolley Cars

THE latest in "go-go" signals is now being operated on trolley cars in Baltimore. The signal consists of two lights, red and green, which indicate when the car is stopping or starting and when it is slowing down.

How signals are placed on cars

When the car is under way, the green light burns; when it is slowing down, the red and green show; and when it stops, the red alone shows.

Birds Have Powder Puffs

HUMAN beings have no monopoly on toilet accessories.

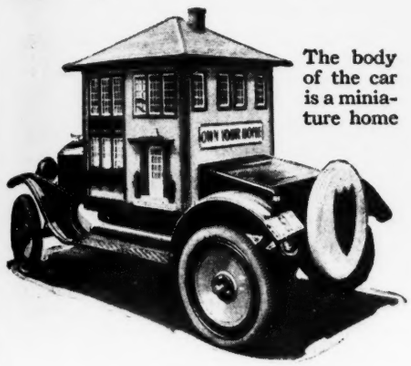
The barn owl, among other birds, has a comb concealed on the inner edge of one of its claws. The English pigeon and the hawk each have a powder puff. The powder is made by certain small feathers that become brittle and crumble into a fine white powder, which the birds use to gloss their feathers.

Novel House on Wheels Boosts Home Owning

TO PROMOTE an "Own Your Own Home" campaign, an Omaha lumber company is using a novel automobile that is really a model house on wheels.

The body of the car is a reproduction of an old English type house decked with flower boxes holding evergreen shrub plants. An electric light attached to the lighting system of the car illuminates the doorway.

The house is complete in every detail, even though constructed on a miniature scale.



The body of the car is a miniature home

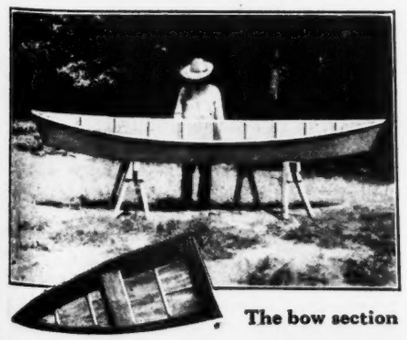
New Glass Letterbox Shows Contents at Glance

ONE glance at a newly invented glass mailbox tells whether the postman has delivered a billet doux or a bill.

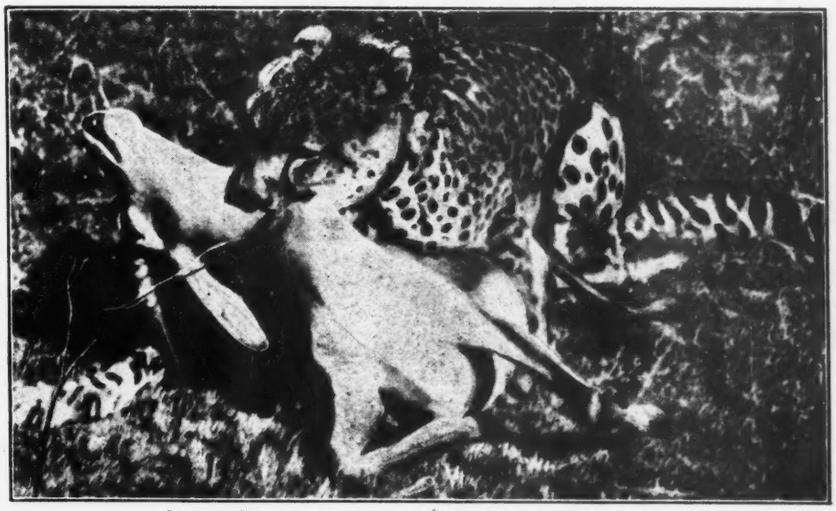
The glass is hard enough to withstand considerable pressure. A strong lock protects letters from theft. Screw holes are so placed that the box cannot be removed when the lid is closed.

Watertight Rowboat Built in Two Sections

A ROWBOAT built in two watertight sections that can be collapsed, to facilitate transportation or storage, has been invented by Adan E. Olson of Holton, Mich. The sections are divided so that one section will fit into the other. They are connected by means of a detachable hinge and pin arrangement so that the boat can be assembled or taken down without tools.



The bow section



Hunting Deer with Trained Leopards

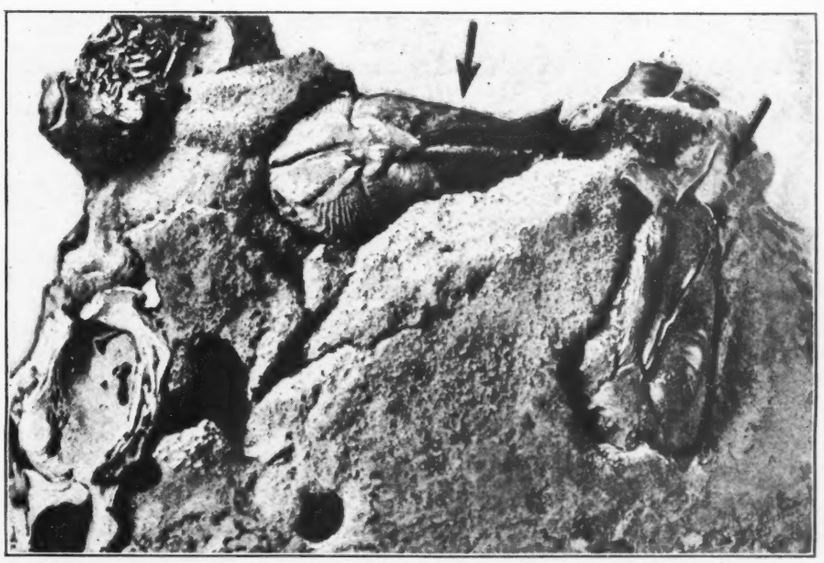
ONE of the world's most spectacular and thrilling sports is that of hunting with cheetahs, or trained leopards, in India. The animals are trained to stalk, kill, and surrender their game to the hunters without mutilating it. The remarkable photograph above shows a cheetah retrieving a deer during a hunt in Baroda State, India.

Cheetah hunting was first developed by Husing, King of Persia, in 865 B. C. Certain of the Mongol kings were wont to go on cheetah hunts, using as many as a thousand leopards.

The cheetah is a beautiful, powerful animal, reddish yellow in color and marked with coal-black spots. In confinement the animal often attains the faithfulness usually ascribed to dogs, being extremely tame and fond of its keepers.

Hooded and chained like a falcon, the cheetah is conveyed to the scene of the hunt in a low car without sides. It is possible to get within 200 yards of the game—antelopes, deer, and such animals—before they take fright. At this point the cheetah is unhooded and released. Springing from the car it slinks to the site where the game is feeding, and with huge bounds it leaps into their midst and brings down one with a blow of its paw. Its share of the booty is a bowl of blood drawn off by natives.

Clams Bore Holes in Concrete Piles



Arrows point to two rock clams boring into concrete coating of pile

USE of concrete for marine construction is not so certain a solution of the marine borer problem as has been assumed, in the opinion of C. A. Kofoid and Robert C. Miller, members of the biological section of the San Francisco Bay Marine Piling Committee. This belief is based on recent investigation of the damage done to concrete-coated piles in Los Angeles harbor by the rock clam.

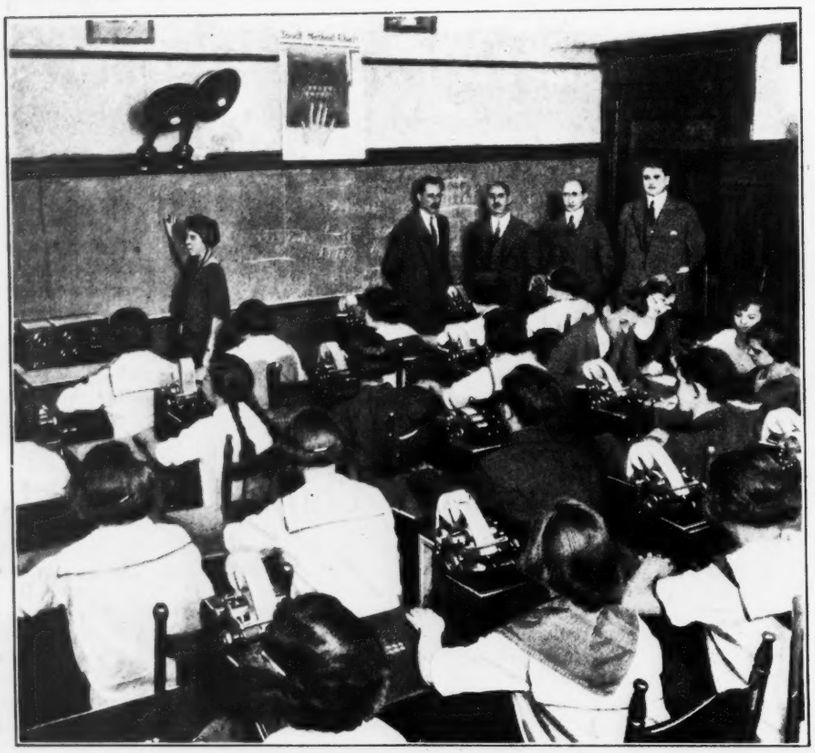
This clam has attacked about half the concrete piles in the harbor. About one fifth of this number were badly bored.

The rock clam works only in hard material. When the wood is reached, inside the concrete, the clam stops boring. The holes left, however, give access to the wood borers.

Just what pile protection will be devised is problematical now. If, as it is now believed, the boring of the rock clam is a chemical instead of a mechanical process, the concrete will not be able to withstand its attacks, no matter how hard the material is constructed.

The problem presented by this discovery is now being closely studied by engineers.

High School Class Taught by Radio



OFFICIALS of the New York City Board of Education and principals of more than 25 city high schools recently witnessed the first successful demonstration of radio for instruction in high school classrooms. At its conclusion they were convinced that eventually radio will offer to thousands of pupils in widely separate localities the advantage of listening to leading instructors and experts with whom otherwise they never would come in contact.

In the demonstration, accountancy was chosen as the subject offering the most conclusive test of this new force in spreading education. From broadcasting station WJZ in Newark, N. J., a series of accountancy problems were broadcast. These problems were received at Haarken High School in New York, where there had been installed a receiver and loudspeaker equipment. Here the students were seated at their adding machines.

Each problem came slowly and distinctly. A few minutes after the lecture was completed, the correct answers were broadcast and received. Then they were checked with the students' results. The general correctness of the classroom work was testimony of the clearness with which radio waves carried.

Radio Brings Hearing to Deaf Boy

ONE of the scientific miracles of the day is that many deaf persons are enabled to hear by means of radio.

Leo Kuehn, of Detroit, Mich., recently heard for the first time in his life when a doctor placed a pair of radio receivers on his ears.

Most deaf persons can hear better over a telephone because of the concentration and amplification of sound in the receiver. When the sound is louder, the sound waves strike the eardrum harder and cause even a rigid drum to vibrate.

In radio instruments, where sound can be amplified almost indefinitely, the possibility of starting the necessary vibrations through loudness of sound is intensified.

Schools for the deaf throughout the country are now making experiments with special radio devices.

Leo Kuehn, of Detroit, Mich., who heard for the first time by radio

IN NEXT month's issue—The first of a series of articles dealing with the development and operation of various modern circuits, by Jack Binns, our Radio Editor.

Valuable facts about the standard single-circuit set, the Flewellyn circuit and the Armstrong single-tube super-regenerative circuit—in the August issue.

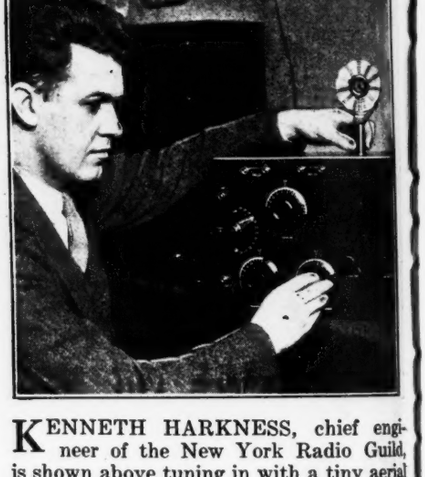
Ingenious Pocket Phone Needs No Antennae

TO the list of novel and ingenious radio appliances is added the invention, by Tracy Hicks of Kansas City, Mo., of a wireless pocket phone requiring little if any antennae and only a ground wire.

The set has a phone at one end of a tube in which is contained the crystal detector and a tuning coil. This tuning coil is set to receive messages in certain wave lengths and the crystal is permanently set.

If sufficiently close to the station, the coil acts as an aerial and only a ground is needed. At greater distances, house wiring circuits or other metallic lines will serve as a ground.

Smallest Aerial Brings in Long Distance Concerts



KENNETH HARKNESS, chief engineer of the New York Radio Guild, is shown above tuning in with a tiny aerial recently designed by him. The aerial is so sensitive that it picks up broadcast concerts on its three-inch coil of wire.

Eighty-five feet of wire, spider-web wound, is used in the construction of the coil aerial. Concerts broadcast from Schenectady, N. Y., have been plainly heard in New York City, a distance of 150 miles, over this set.

Aurora and Thunderstorms Affect Messages

THAT thunderstorms and the aurora borealis affect the audibility of radio messages has been definitely established in recent experiments by the Weather Bureau of the United States Department of Agriculture and by the reports of northern radio stations. Atmospheric conditions seem to have no effect except as they affect the electrical condition of the air. The barometric pressures at either the sending or receiving stations also have no effect on the audibility.

Silencing Shrieks and Groans in Sensitive Radio Sets

Our Radio Editor Announces Important New Inventions

By Jack Binns

THE world of radio is astir with the most important divorce case in its brief but spectacular existence. It is the divorce of radio frequency amplification from radio regeneration.

And the outcome of the separation, fraught with great possibilities for the future of wireless, is to silence the shrieks, groans, and whistles of regeneration that have marred the enjoyment of supersensitive receiving sets. No longer will choruses of chirping birdies pipe in on grand opera, or emerge with the Sunday sermon from the radio frequency receiver.

This transformation has come about through the efforts of Prof. L. A. Hazeltine of the Stevens Institute of Technology, one of the foremost radio experts of the country. He has succeeded in doing what other experts almost had despaired of doing. He has invented a new system of amplification that bids fair to draw a complete dividing line between radio frequency amplification and regeneration.

This invention, involving the principle of tuned radio frequency, opens up untold possibilities for the development of supersensitive sets. It is revolutionary for the following reasons:

First, it permits a step up ratio in the interstage transformers; second, it achieves amplification without a trace of regeneration; third, it permits the use of any type of hard vacuum tube, irrespective of individual characteristics; and, finally, it provides what all investigators have long sought—a receiver that is incapable of radiating energy. Thus it removes from future radio development a troublesome source of interference.

The new "neutrodyne" squealless radio receiver and its inventor, Prof. Louis A. Hazeltine, of the Stevens Institute of Technology, at the left. This receiver uses two stages of tuned radio frequency, detector, and two stages of audio frequency amplification. It will work without any aerial or ground

How the New System Works

The new system, called the neutrodyne, is based upon capacity neutralization. That term sounds very terrifying; really it is very simple. For example, take two conductors of electricity. If they are placed close together in a parallel position, separated by a non-conductor, they immediately act as a condenser. In other words, they are susceptible to an electrostatic charge, the capacity of which will depend upon the area of the conductors and the nature of the non-conductor between them.

Now, assuming the position of two conductors as outlined above, it naturally follows that the grid and plate elements inside a vacuum tube form a condenser. This condenser, although of very small capacity, is nevertheless really important in its effect, because it provides an electrostatic coupling between the grid and plate circuits of the radio receiver, and so produces a feed-back action.

This feed-back action becomes more pronounced the lower we go in the scale of wave lengths. The reason for this is found in the fundamental principle that the shorter the wave length the higher will be the frequency of the current involved, and high frequency alternating current finds an easy pathway through a condenser. This is the factor that has delayed the development of radio frequency amplification on short waves. Even now it remains a problem, because of the tendency of the circuit to enter into an oscillating condition through the feed-back action in the tubes of the radio frequency stages, hampering clear reception. The oscillations of radio frequency circuits have been kept subdued to a certain extent by means of potentiometer control, but to accomplish this a great deal depends on the transformers and general construction of the set.

Professor Hazeltine has attacked the problem presented by electrostatic or capacity coupling in an entirely novel manner, with the result that his new receiving set is absolutely quiet in operation, and remarkably free from distortion of sounds. It seems to be the ideal set of the future.

The principle involved is one that figures largely in all kinds of electrical operation—the balancing of two forces of equal value against each other so that they neutralize and so eliminate the effect that either one alone would cause.

The neutrodyne receiver accomplishes this balancing and neutralizing by means of condensers. In other words, Professor Hazeltine has destroyed capacity feed back action in radio frequency amplifying circuits by the process of opposing the condenser that exists in the vacuum tube with another condenser of exactly the same capacity. As a result, the tubes, while in operation, cannot possibly get into an oscillating state and the circuit in which they are being used cannot heterodyne upon the incoming carrier wave to cause the regenerative whistle. In addition, it is impossible for the tubes to feed back energy to the aerial circuit, therefore the receiver in which the system is employed cannot radiate energy from the aerial to annoy other listeners.

Through the employment of this system it has been possible to obtain a step up ratio of four to one in the interstage transformers. But since the tuned system of radio amplification is used, these transformers are of entirely different construction to the types now in general use.

It is in the novel construction of the neutralizing condensers, however, that the main interest of the new system lies. These are the smallest variable condensers ever made, yet they are the acme of simplicity. They consist of two wires around which an insulating material is wrapped, the two wires being separated from each other. They are inclosed by a metal cylinder just large enough to slide over them.

Is Equivalent to Two Condensers

This arrangement is equivalent to placing two condensers in series. Since it is a fact that when two condensers of equal capacity are placed in series with each other the resulting capacity in the circuit is only one half that of either of them, it will be seen how small the total capacity of this little condenser really is. Condensers of this type have already been made as low as .000001 microfarad, or one millionth of a millionth of a farad.

The manner in which the condenser is adjusted to neutralize the capacity of the tube is another novel feature. When the receiver has been turned on in the usual way, it is tuned to a very strong

signal coming from a transmitter in the laboratory. The filament of the first tube is then turned off, but the capacity coupling tube is sufficient to pass the signal through the rest of the receiver. The neutralizing condenser then is put in the circuit and adjusted until the signal disappears entirely, which is at the point where the capacity matches that of the tube. Since these adjustments are made with the filament cold, regeneration is impossible, for no electronic stream flows from the filament.

While the new system is extremely easy to operate, it is not a circuit for the radio fan to build—at least not yet. It requires specially made and adjusted neutralizing condensers to fit the capacity of whatever type of tube is used with it. To work effectively these condensers must be constructed where there are good manufacturing and laboratory facilities.

But the invention does offer wonderful possibilities for the future. Reducing the interstage tuning to one control apparently removes all limits to the number of radio frequency amplifying stages that can be used in a set embodying the new principle. Remarkable results have already been obtained from the receiver. It has demonstrated that it can take its place with the best developed of the supersensitive receiving sets.

Keep a Step Ahead in Radio

THE wireless operator who flashed the world's first "SOS" distress call nearly 15 years ago is now flashing to readers of POPULAR SCIENCE MONTHLY the FIRST NEWS of important events and inventions in radio as they occur from month to month.

Today Jack Binns, the hero of the sinking steamship "Republic," is recognized as one of America's foremost popular writers on radio. No other writer in the field of radio is so thoroughly grounded in his subject or has so broad a vision of its future possibilities.

To get all the important radio news FIRST, read what Jack Binns has to say every month in POPULAR SCIENCE MONTHLY.

The New Dry Cell Vacuum Tubes

THE advent of new and improved dry cell vacuum tubes has taken away from ordinary radio frequency amplification one of its chief drawbacks—the storage battery. It is now possible to construct a six-tube set using dry cell tubes throughout.

There are some precautions, however, to be observed in using the new tubes, in order to get the best possible results. First, since they are hard tubes, they should have from 40 to 45 volts in their plate circuits when they are used as detectors.

In using them as audio frequency amplifiers, 100 volts can be placed on the plate circuits in order to get sufficient volume to operate a loudspeaker, but in doing so the grids of the amplifying tubes should be kept negative with a three-volt biasing battery.

For radio frequency amplification the standard circuit with the usual potentiometer control of the grids of the amplifying tubes can be employed.

The new dry cell tube filament consists of thoriated tungsten, which has a large electronic emission at very low temperatures. For this reason both the voltage and current should be kept as low as possible consistent with good results.

Because of the efficiency in emission of electrons from the filament, the tube oscillates very readily. If radio frequency transformers of poor design are used, considerable trouble will be experienced. It may be necesary to employ a resistance in the loop circuit, as shown in the accompanying diagram, in order to quench the oscillations. This is not recommended as general practice.

Another method of keeping down oscillations in the radio frequency stages is to reduce the plate voltage. This may tend to reduce the range of the receiver, but much more stable reception will be obtained. If the plate voltage is reduced without the use of a potentiometer in the circuit, it is very important to observe the following arrangement of the grid circuits.

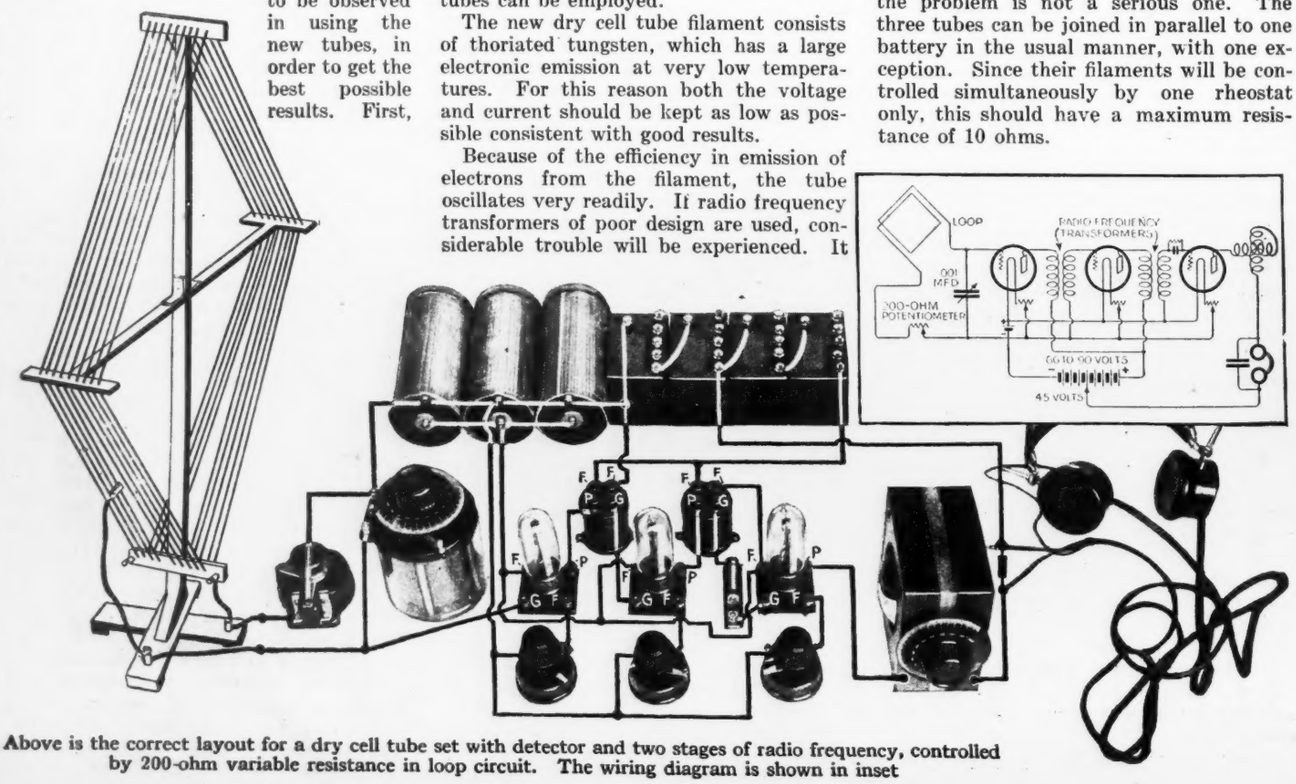
The grid circuit is from the grid through the secondary of the radio frequency transformer to the filament. In the first stage, of course, the return is through the loop to the filament.

Arrangement of Circuits

First, the rheostat controlling the tubes should be in the negative side of the A battery leads, as shown in the diagram. Second, that part of the grid circuit which is connected with the filament should be placed on the A battery side of the rheostat, and not between the rheostat and tube. This arrangement puts the necessary negative bias on the grids of the amplifying tubes. The exception to this is in the case of the detector tube where a grid leak and condenser are used. Here the grid circuit must be connected with the positive side of the A battery.

Another important thing to remember in using the new tube is that it is designed to operate at full efficiency on three volts.

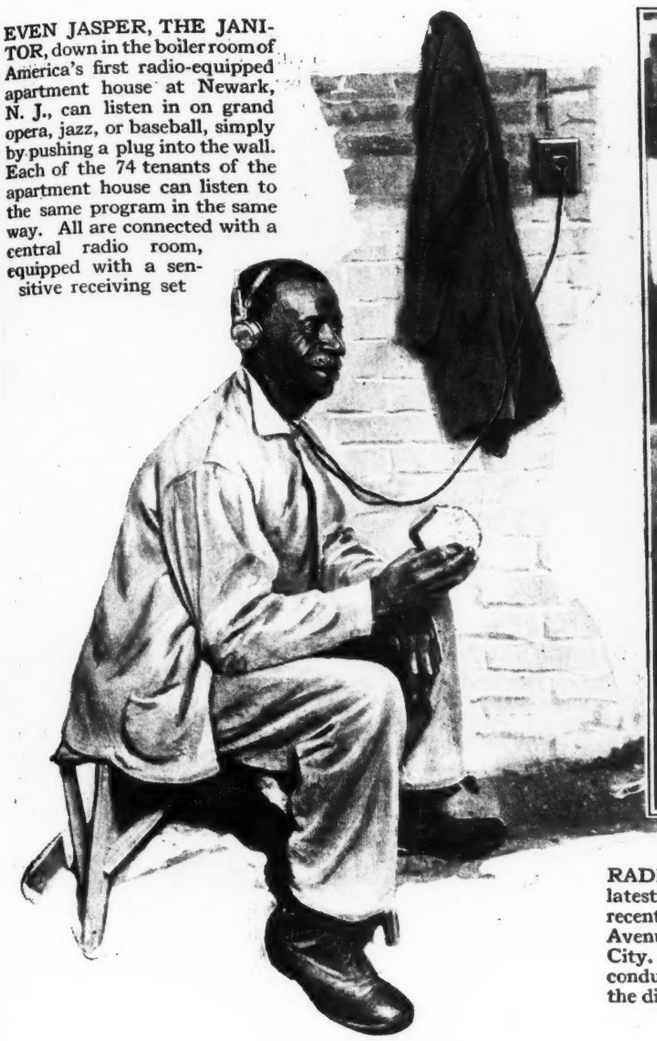
In circuits using three of the tubes—such as three stages of radio frequency amplification as a separate unit, or in sets employing a detector and two audio stages, the problem is not a serious one. The three tubes can be joined in parallel to one battery in the usual manner, with one exception. Since their filaments will be controlled simultaneously by one rheostat only, this should have a maximum resistance of 10 ohms.



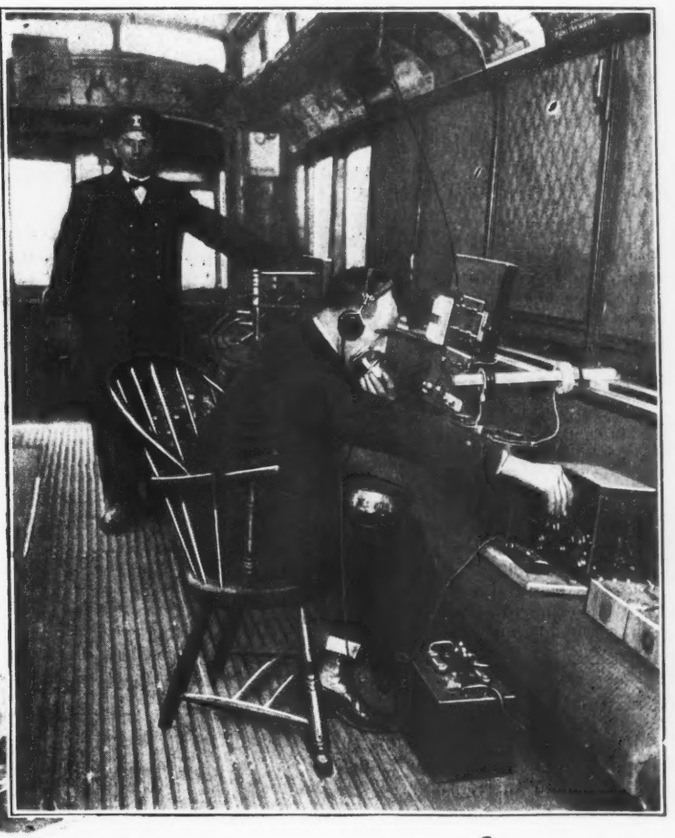
Above is the correct layout for a dry cell tube set with detector and two stages of radio frequency, controlled by 200-ohm variable resistance in loop circuit. The wiring diagram is shown in inset

Watch Radio Grow

In Boiler Room and Streetcar; along Curb and on Horseback



EVEN JASPER, THE JANITOR, down in the boiler room of America's first radio-equipped apartment house at Newark, N. J., can listen in on grand opera, jazz, or baseball, simply by pushing a plug into the wall. Each of the 74 tenants of the apartment house can listen to the same program in the same way. All are connected with a central radio room, equipped with a sensitive receiving set

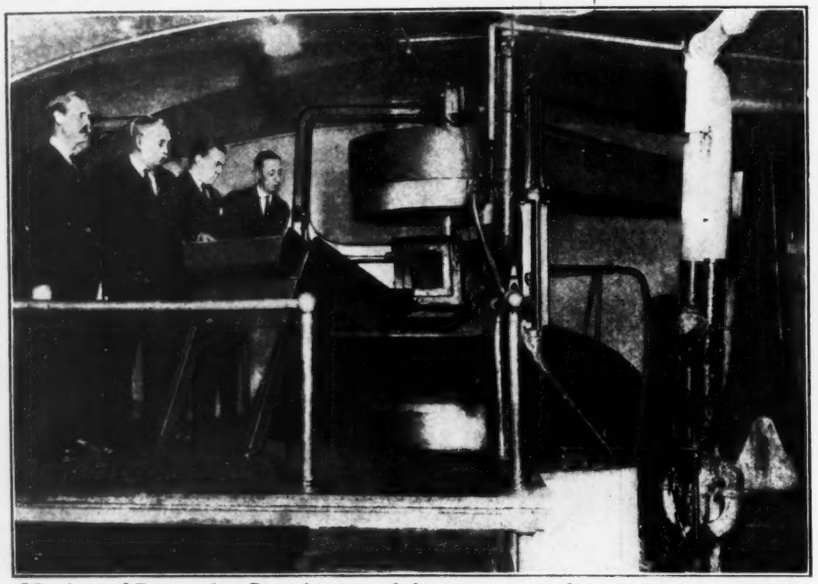


RADIO ON STREET CARS is the latest method of handling trolley traffic recently tried successfully by the Third Avenue Railway Company of New York City. With transmitter and receiver, the conductor keeps in communication with the dispatcher. Overhead trolley wires are used to direct the radio waves

AND NOW COMES HORSEBACK RADIO—John Osborne, Philadelphia business man, created a stir in Fairmount Park the other day when he appeared along the bridle path on his horse equipped with a complete radio outfit. Note the loop aerial supported by the saddle

THE PASSING OF THE HURDYGURDY is heralded by the appearance on London streets of a radio barrel organ drawn by a donkey. The music box contains a complete radio receiving set with a loudspeaker, surmounted by a tiny aerial

Millions of Dollars Destroyed Daily



Members of Destruction Committee watch huge macerator destroy outworn currency in the Treasury Department, Washington, D. C. The machine is fastened with three locks, the keys of which are held only by the committee

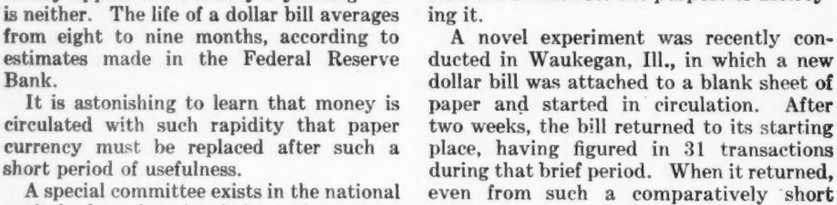
REACH down in your pocket and pull out a dollar bill. It may look a hundred years old if it has had hard usage, or it may appear to be merely a yearling. It is neither. The life of a dollar bill averages from eight to nine months, according to estimates made in the Federal Reserve Bank.

It is astonishing to learn that money is circulated with such rapidity that paper currency must be replaced after such a short period of usefulness.

A special committee exists in the national capital whose function it is to observe the destruction of paper currency that has outlived its usefulness. Millions of dollars are tossed daily into a huge chopping machine devised for the purpose of destroying it.

A novel experiment was recently conducted in Waukegan, Ill., in which a new dollar bill was attached to a blank sheet of paper and started in circulation. After two weeks, the bill returned to its starting place, having figured in 31 transactions during that brief period. When it returned, even from such a comparatively short journey, it was dirty and crumpled.

Ship Uses Suction to Catch Fish



NOW being fitted out in New York is a ship equipped with a recently invented mechanical fishing device, whereby the catching of large quantities of fish in record time and at minimum expense can be accomplished.

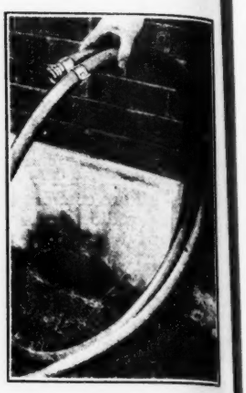
How the Catcher Operates

The mechanical fish catcher consists essentially of a tube extending from the bow to the stern of the boat, emptying into a trap. An adjustable telescopic net is situated at the bow of the boat. This net leads to openings that are connected with the tube at either side of the bow. Within the tube an artificial current carries the fish and water into the trap. The current is created by an eight-inch centrifugal pump driven by a motor, causing a suction force at the forward end that helps pull in the fish.

The equipment delivers approximately 66,000 pounds of fish and water a minute into the trap. Of this amount from 10 to 20 per cent should be fish, according to the inventors. Assuming a mean of 15 per cent, the tube will deliver 9900 pounds of fish a minute when in a school. The water flows overboard, while the fish are retained in the netting of the trap.

Going through a school with the equipment working, a tremendous amount of fish can be caught in a short time, its inventors say. The matter of getting into a school is considered simple, as the fish are not easily stampeded when traveling in large numbers.

Garden Hose Roller to Replace Heavy Reel



A SIMPLE metal device attached to the end of a garden hose at right angle to the natural coil has recently been put on the market as a substitute for the hose reel. Once the device clamps the end of the hose to a bend of the coil, the remainder may be rolled up, and hung on a peg.

Roller Window Screen Works like Window Shade

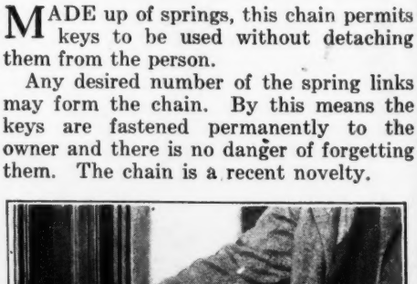
A NEW automatic roller window screen that operates like an ordinary shade, has just been perfected.

The screen is of waterproof fiber cloth, the strands locked at every mesh by a patented process. The top fits the bottom of the window so when the latter is raised, the screen automatically follows. When the window is closed, the screen disappears into a metal case attached to the sill. The part fitting the bottom of the window is detachable so that even a child can lower the screen to adjust an awning, close a shutter, or shake out a dust rag.

Here's a Key "Ring" that Will Stretch

MADE up of springs, this chain permits keys to be used without detaching them from the person.

Any desired number of the spring links may form the chain. By this means the keys are fastened permanently to the owner and there is no danger of forgetting them. The chain is a recent novelty.



Chain stretched from pocket to lock

The Ideal Swimming Stroke Found by Science

Double Trudgeon Crawl Helps Champions and Beginners Alike

By Edward T. Kennedy
Swimming Coach, Columbia University

REACHING out into the sport of swimming, science is proving once again that the best way is the simplest way.

Through scientific study of various strokes, experts recently have developed a method of propulsion which, while it has made "learning to swim" an easy problem for the beginner to master, has produced John Weismuller, the swimming speed marvel of the world.

It is called the "six-beat double-trudgeon crawl." Sounds technical and difficult, doesn't it? Yet the foremost swimming instructors and experts agree that it is the ideal stroke for beginners and champions alike.

JOHN WEISMULLER, world's swimming marvel, who has used the scientific six-beat double-trudgeon crawl stroke to smash all national swimmlng speed records for distances from 50 to 440 yards. In a recent swimming meet at Columbia University he swam 100 yards in 53 seconds flat, clipping one fifth of a second from his own international record, and equalling the world's open water record held jointly by Duke Kahanamoku and Pua Kealoha of Honolulu

An Easy Stroke to Learn

The beginner, accustomed to struggle laboriously with the old-fashioned, lumbering breast stroke, need no longer envy the "overhand" swimmer plowing swiftly through the waves. He can forget the slow, uninteresting "spread eagle" method and can strike out swiftly for himself. A little practice will bring about a marked improvement; it will make him a strong, speedy swimmer, ready for any emergency.

The six-beat trudgeon crawl has made it possible for the men and women swimming champions to set new speed records for all distances. Weismuller, Norman Ross, Ludy Langer, Richard Howell, Claire Calligan, Charlotte Boyle, Ethelda Bleibtrey, Helen Wainwright, and Gertrude Ederle—all have mastered and used it.

Just as it has increased their speed and endurance in the water, so it will increase the speed and endurance of the most awkward amateur who practises it. In fact, the beginner's improvement will be more marked than that of the expert, for the new stroke will reduce waste of effort and utilize his strength and stamina to the best possible advantage. While it is a real achievement for the racing swimmer to clip a fifth of a second from a record, it will be an easy matter for the average swimmer to cut down his time for any distance by minutes.

This most scientific of all swimming strokes is easy because it is natural. You simply float out on the water, face downward, arms extended, body slightly arched from head to toes, then use your arms as water wheels and your feet as propellers. If you are a beginner, all you need is a bit of confidence. Your lungs are full. You can't sink. As your arms and legs drive you forward, at every full stroke you roll your body to one side, open your mouth, and take a fresh breath of air for the next dip.

Rolling to one side at the end of his stroke, Norman Ross, one of America's greatest swimmers, raises his face and inhales air through his mouth

To learn the stroke, first practise the leg drive; next, try the arm movements, and finally the rolling and breathing. This is how to do it:

The Leg Drive—Lie out flat on the water, face downward, and move your legs in short alternating thrashes like the beat of drumsticks. One leg moves downward, while the other moves upward. While doing this, hold the legs almost straight yet free from tension in order to allow for slight play at knees and ankles. Point the toes and turn them slightly inward, as if pigeon-toed.

The Arm Movement—The arms move like two paddlewheels, in long, alternate sweeps. Each arm in turn is extended full length in front and enters the water with the elbow slightly higher than the hand, forearm and hand alined, palm down and flat, fingers and thumb close together. The hand enters the water at one side of an imaginary line through the middle of the body. Now sweep the arm downward and backward, bending it so that the elbow hooks outward and so that the hand will move in an arc beneath the body until it nears the thigh. Here the arm swerves outward in such a way that the hand and forearm retain leverage on the water as they are brought to the surface. Just before the hand emerges, the palm is turned inward. As the hand clears the water, it is flipped gently from the wrist toward the body, but the forearm continues to move outward as the flip is effected and circles outward, until it points ahead. Then, after the bending of the arm is completed, the elbow moves forward and the arm glides out straight again to easy full reach in front, keeping a few inches above the surface of the water and sloping slightly downward after the hand passes beyond the head.

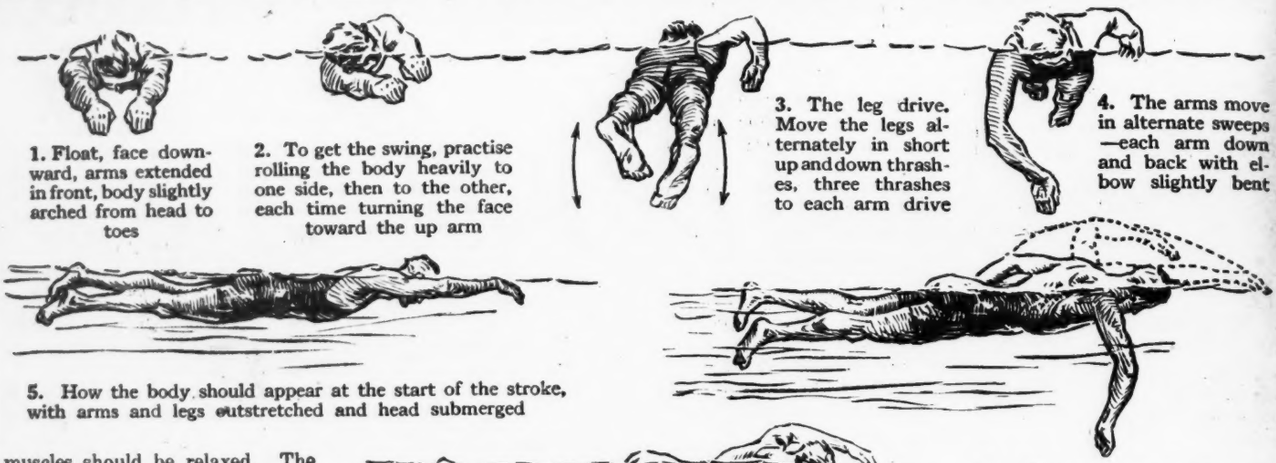
Stroke Supports Shoulders

During the stroke the arms should be moved independently of the body so that the shoulders will not follow their movements. The movement of each arm should be timed so that it will start its drive from the front before the other arm, completing its drive, relinquishes its pressure on the water at the rear. The catch, or entry of the arm into the water, should be made with sufficient vigor to support the shoulders. The power must then be increased until the arm has reached a point beyond the perpendicular position.

Study carefully the illustrations at top of next page.

As the hand leaves the water, the

How to Swim with a Championship Stroke



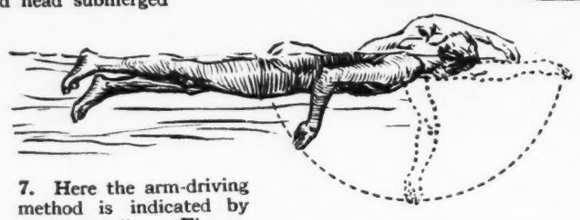
1. Float, face downward, arms extended in front, body slightly arched from head to toes

2. To get the swing, practise rolling the body heavily to one side, then to the other, each time turning the face toward the up arm

3. The leg drive. Move the legs alternately in short up and down thrashes, three thrashes to each arm drive

4. The arms move in alternate sweeps—each arm down and back with elbow slightly bent

5. How the body should appear at the start of the stroke, with arms and legs outstretched and head submerged



7. Here the arm-driving method is indicated by the dotted lines. The extended driving arm enters the water with forearm and hand alined, palm down and flat. Sweep the arm downward and backward in an arc under the body, bending it so that the elbow hooks outward

6. The dotted lines above show the method of recovery with one arm, while the other arm drives downward and backward through the water. After the hand clears the water for recovery, the arm is bent and the forearm circles outward until it points ahead. Then the arm glides out straight again to full reach in front

muscles should be relaxed. The bending of the arm immediately afterward should be quick, but the forward glide exceedingly slow, to permit a rest between efforts.

Arms and Legs—The strokes of arms and legs should be timed so that three scissoring motions of the legs (one up, one down, one up) are performed to one drive of each arm, or six scissoring motions to each full stroke. The first and fourth of the six leg motions should be more pronounced than the others. These two wider strokes (called majors) should not exceed a movement of more than 13 or 14 inches; the lesser strokes (called minors) not more than from 6 to 8 inches. The thrash of the legs should be easy.

Breathing—Breathing is accomplished by rolling the body and moving the head to one side, whichever side is preferred. This brings the face above water so that the swimmer can inhale a breath of air through his mouth during the recovery of the arm on that side. Then the body rolls back, the head is submerged again, and the swimmer exhales through the nose under water during the recovery of the other arm. During the roll, which, by the way, should not be pronounced, it is very important to start the drive of the under arm before turning the head to inhale and to start the drive of the top arm before turning the head to the submerged position.

Learning to Roll

In learning the stroke, it is good practice at first to roll the body heavily to each side, turning the head toward each arm as it sweeps forward above the surface. But once you have learned to coördinate arm and leg action and breathing, abandon this practice. You should roll only to one side to inhale, aiming to conform more and more with the requirements of the standard stroke.

The superiority of the six-beat double-trudgeon crawl is due to the fact that, more than any stroke devised so far, it meets the scientific requirements of effective progression in the water—natural and efficient movements, continuous application of arm and leg power and avoidance of unnecessary resistance.

All movements are easy and unstrained, yet they give good play to the muscles, afford direct forward impetus and eliminate loss of motion. Propelling force is attained without break in the movements of arms or legs. Resistance is reduced to a minimum, not only because the position of the body and steady progress enable the swimmer to take advantage of the hydroplaning principle, but because the arms recover above water and the leg drive is the narrowest evolved to date.

We owe the discovery of the six-beat double-rhythm stroke to American students of the science of swimming. They worked it out in theory several years before it was tested for practical use. At first the leading coaches and swimmers could not be induced to give it a trial, claiming that the fast leg thrash was entirely too tiring to be maintained successfully for more than about 100 yards.

HERE is Claire Galligan, of the Women's Swimming Association, who,. with Charlotte Boyle, first developed the six-beat double-trudgeon crawl stroke. After other experts had declared the stroke impractical, these two women proved it to be the most scientific and effective of all swimming strokes. With it they set new speed records

Records Broken with Stroke

So it was left to two New York girls—Miss Claire Galligan and Miss Charlotte Boyle, of the Women's Swimming Association—to prove the value of the stroke. They took it up experimentally in the fall of 1917. A few months later they startled the aquatic world by using it in the women's 500 yards national championship race, which Miss Galligan won. And the following summer both girls succeeded in shattering speed records with it, up to one mile, clinching the evidence of its worth.

One of the outstanding advantages of the six-beat crawl is that it does not require fast arm movements. On the contrary, the steady leg drive permits slowing up the arms without loss of momentum, thus making it possible to retard the recovery and seek complete relaxation between arm pulls. A rapid stroke will prevent full development of either speed or endurance.

Try out this stroke this summer. Time yourself for 100 yards when you first take it up, and again after a month's practice. You will be surprised at your improvement.

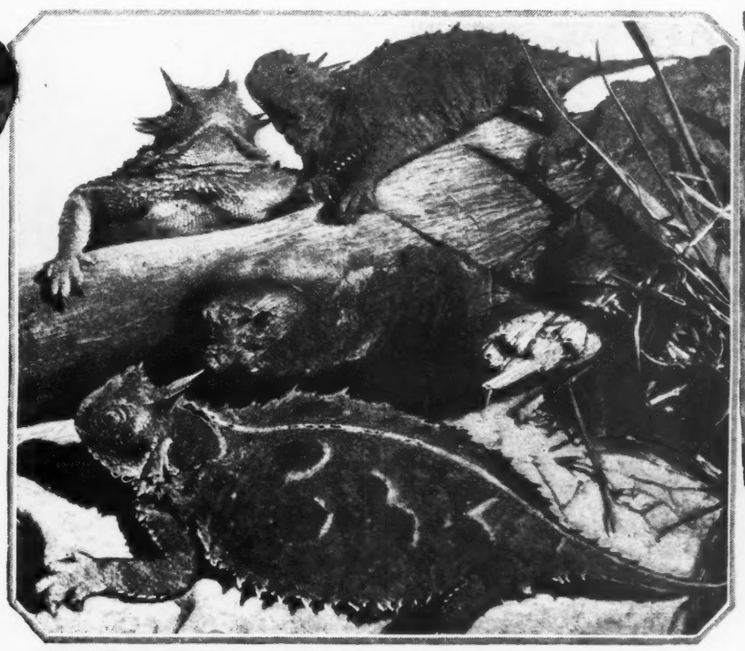
Friends of the Home and Garden

THIS HARMLESS TREE FROG is a friend of the farmer and backyard gardener alike; for it devours countless insects that are injurious to food plants and to grass. It also feeds on disease carrying flies and mosquitos. Thousands of these valuable little creatures are killed thoughtlessly every year

THE BAT, TOO, FEEDS ON PESTS, yet, through the fear and ignorance of human beings, these strange winged mammals usually are killed whenever they chance to enter a home

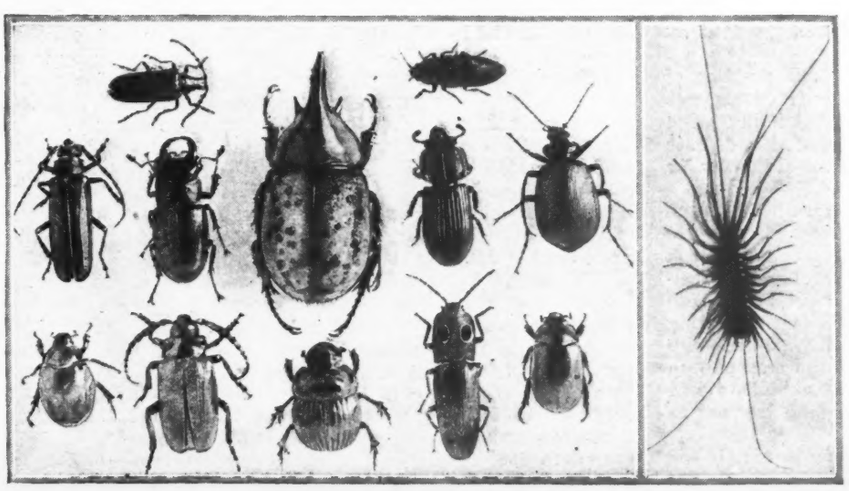
Photographs from life by Dr. R. W. Shufeldt, courtesy *The Junior Red Cross News*

HE MAY LOOK SLEEPY, but the barn owl above is death on mice. One or two pairs of these birds on a farm, if protected and allowed to rear their young, will catch hundreds of mice every season



THESE HORNED LIZARDS, incorrectly called "horned toads," are thought to be enemies of man. Instead, they are harmless and make gentle and interesting pets. They are found chiefly in the southwestern part of the United States, where they feed on flies and insects

SAVES THE TREES — Were it not for the industry of the noisy red-headed woodpecker our woods would be stripped of many valuable trees by insects and their larvæ on which this handsome bird feeds



HARMLESS BUGS —At the right are a dozen of the 80,000 different kinds of beetles that form the largest group of creatures in the animal kingdom. They are characterized by hard, sheathed wings. Most of them are harmless and will mind their own business, if left alone

NOT POISONOUS —The belief that the thousand-leg bug (at left) inflicts a venomous bite is false. This creature, often seen running about the house, has been feared and destroyed by housewives, yet it feeds entirely on flies, cockroaches, and other household pests

What Every Motorist Owes to the

Awaiting the starting gun at the first motor racing event of the 1923 season—the 250-mile championship race, won by Jimmy Murphy on the Los Angeles Speedway

By E. V. Rickenbacker

Former Race Driver and American Flying Ace

AUTOMOBILE manufacturers are going back into their great motor laboratory—the speedway. Not for the sport of it; not for the big cash awards given the winners; but for its scientific value to the industry. The Packard Company is the first big concern to announce its return to the track. Its cars are expected to figure prominently in this season's events.

Twenty years ago Henry Ford drove one of his first cars out to the old Grosse Point racetrack in Detroit and there, in a thrilling test of speed, matched his creation against the car of Alexander Winton.

What Henry Ford Learned

Ford won. And in winning he learned some valuable new facts about the construction of automobiles. He learned, for example, that the action of springs under great strain is different from their action on a boulevard at ordinary speed. He learned that vibration is likely to break fragile parts. The wear and tear of the racetrack revealed to him weaknesses in construction and materials that were not apparent under normal conditions.

In correcting these weaknesses, in profiting by experience, Ford produced a car that is one of the marvels of the century.

Other manufacturers followed Ford's example. In the early days they took their cars to the speedway laboratory to test them in the crucible of racing. They, too, learned their lessons and profited by them.

Then came the war. The practice of entering stock cars in speed events was discontinued. But the thundering grind of the track had accomplished a definite result: It had established one of the wonder industries of history.

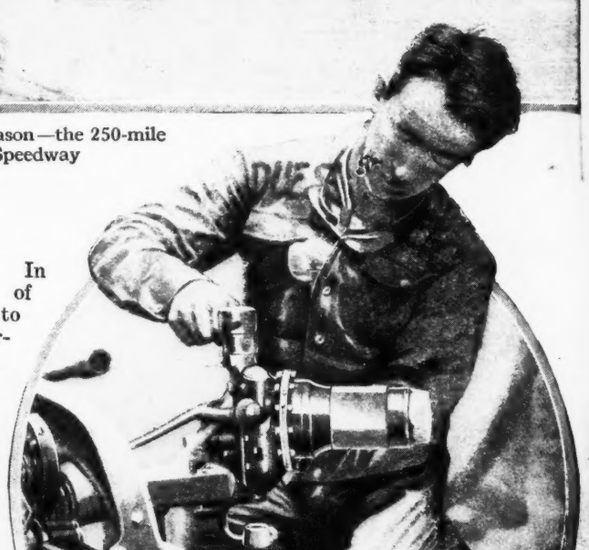
The automobiles that are so indispensable in business and pleasure today are marvels of simply operated mechanism just because they passed through the grueling tests of speed. We drive them in comparative safety and comfort because daring speed kings risked their lives, burned up tires, broke steering gears and crashed into the ditch, or because they skilfully tuned and nursed their throbbing steeds to breathless victories.

And now the makers are returning to the speedway in the hope of still greater engineering achievements. In the further development of motor cars they hope to duplicate the record of fearless race drivers of the past.

Just what is this record? How is it reflected in the modern automobile?

First, in the efficiency of the small, powerful engine. The evolution of the engine from the early models, with a piston displacement of 1000 cubic inches to the present 122 cubic inch size, took place almost entirely on the speedway.

In the early days of racing, an outstanding feature of cars entered by manufacturers was the ever increasing size of the engines, which eventually reached the size of 7¼-inch bore and six-inch stroke. The piston displacement was 1000 cubic inches and the speed of the engine 1200 revolutions a minute. These big cars weighed 2800 pounds—just twice as much as the cars entered this season.



Jimmy Murphy, international racing champion, repairing a broken steering knuckle at his pit

From 1905 the size of engines began to decrease and the engine speed to increase. The first step in this development was to limit the piston displacement to 600 cubic inches and increase the speed to 2000 revolutions. Next, in the races of 1913, the piston displacement was limited to 450 inches and the speed increased to 2500 revolutions. It was at this stage that overhead valves were first used on race cars. Again, in 1915, piston displacement was cut to 300 inches. With a car of this class Ralph De Palma hung up a record of 89.84 miles an hour for 500 miles. Seven years later, Jimmy Murphy broke this record with a piston displacement of 183 inches.

The small engines of 1922 were considered the last word in engine reduction. Designers and manufacturers agreed that any further limitations in size would kill speed. Yet the cars entered for the 500-mile race at Indianapolis this year were limited to 122 inches and the speed advanced to 5500 revolutions. This is considerably smaller than the displacement of engines in the popular priced small cars now on the market. But the engines are as powerful as ever and more economical.

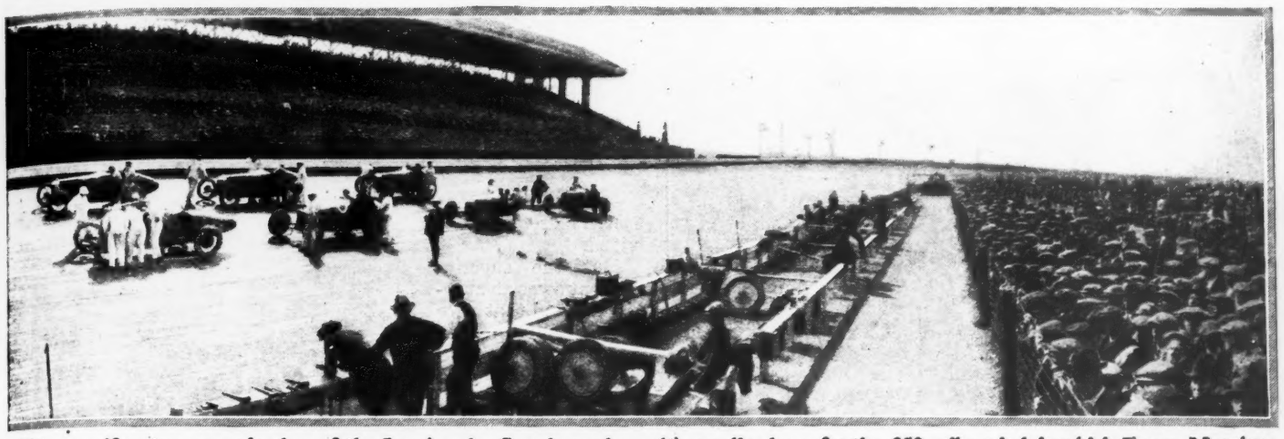
I have gone to some length in describing these engine changes, simply to show the effect of the racetrack on the design of modern commercial cars. If you owned a car 10 or 15 years ago, you will recall the large bore of the engine. And you will recall how, year by year, the size has decreased and efficiency has increased, in step with every development on the speedways of the country.

Europe Working on Small Car

I am firmly convinced that the 122-inch engines of this year's race cars will be adopted generally for commercial cars within a year or so. Even now, in Europe, manufacturers are experimenting with cars much smaller than any ever made successfully in this country.

Reduction in engine size naturally has resulted in decrease in consumption of fuel. In fact, the fuel saving has been almost 400 per cent. With the rising price of gasoline, this single economy is tremendously important to every consumer.

the Heroes of the Speedway



This magnificent panoramic view of the Los Angeles Speedway shows 15 cars lined up for the 250-mile grind in which Jimmy Murphy established a record average speed of 115.8 miles an hour. From such contests were born many improvements of the modern automobiles

The development and improvement of tires is a second striking outgrowth of the speedway. At the outset, tire trouble was the scourge of the racetrack. Public attention was called to this weakness nearly 20 years ago, when Barney Oldfield went through the fence on a Detroit track. In this instance a blowout caused the accident. Blowouts occurred frequently as long as fabric tires were used in racing. Even with the later introduction of cord tires, the increased speed of cars and the more severe conditions of the speedway tracks still caused considerable tire trouble.

The Cord Tire Proves Its Worth

In the first 500-mile race at Indianapolis in 1911, Wilcox had 13 cases of tire trouble. Other drivers also suffered. Oil on the tracks caused the treads to come off in strips. The next year there were fewer cases of tire trouble at Indianapolis, and in 1913 Ralph Mulford established a record by going the full 500 miles without a tire change. He finished in the money. Tires still cause a great many stops but speed, heat, track conditions and other factors enter into the case.

As was true of the engine, commercial car makers followed the example of the racetrack. Here again the merits of cord tires as demonstrated on racing cars has resulted in their general use on passenger cars.

Another outcome of tire trouble on the track was the introduction of the demountable rim now used on nearly all automobiles. This feature was introduced first by the driver of a Renault car in the 1905 Gordon-Bennett race in France. It was the forerunner of the demountable wheel now used almost exclusively in racing and which in turn has been adopted by many manufacturers of high class cars.

Use of wire wheels, too, may be traced to the speedway. There was a scientific reason for their appearance. Besides carrying the weight of the car in suspension, and thus affording greater safety than supporting it on wooden spokes under compression, the wire spokes aided in radiating the heat from tire friction. Wood, a non-conductor of heat, kept the tires hot, while wire helped to carry the heat away.

Lack of stability in the wooden wheel was strikingly demonstrated in the Indianapolis race of 1912, when Bob Burman and Marguette were put out of the running by the collapse of wheels.

Commercial car builders were not long in adopting the wire wheel after racing had proved its superiority, and it became extremely popular. In recent months its popularity has waned somewhat. Yet while well built wooden wheels undoubtedly are adequate for ordinary driving, engineers still consider wire wheels the more durable and safer form of construction.

Another weakness in automobile construction, affecting the steering gear and reciprocating parts of the engine, was revealed on the speedway. Race drivers found by bitter experience that under great strain and vibration the steel in their cars tended to crystallize. It became brittle and broke easily. This weakness resulted in a catastrophe at the first Indianapolis race, when Jagersburger, in a Case car, broke a steering rod. In trying to dodge him, Harry Knight, who was following in a Westcott, crashed into an Apperson standing at the pit. Both cars were wrecked.

Incidents like this were common in the early days of racing. Nowadays they are rare because engineers have concentrated on the production of steel that will stand the terrific strain; yet even last year a broken steering knuckle caused the death of Roscoe Sarles at Kansas City.

In such measure do we owe our present driving safety to the fearlessness of the "speed demons"—true sportsmen all—who smile in the face of death and point the way to progress.

Remember that when a driver drops out of a heartbreaking race, the fault does not always lie in a weakness of his particular car. More often he is the victim of some inherent imperfection that remains to be overcome in the science of motor construction. It was such an imperfection that eliminated Ralph De Palma from the 500-mile race of 1912. Just when victory was within his grasp, when he was leading by 11 minutes and had only two laps to go, a piston broke!

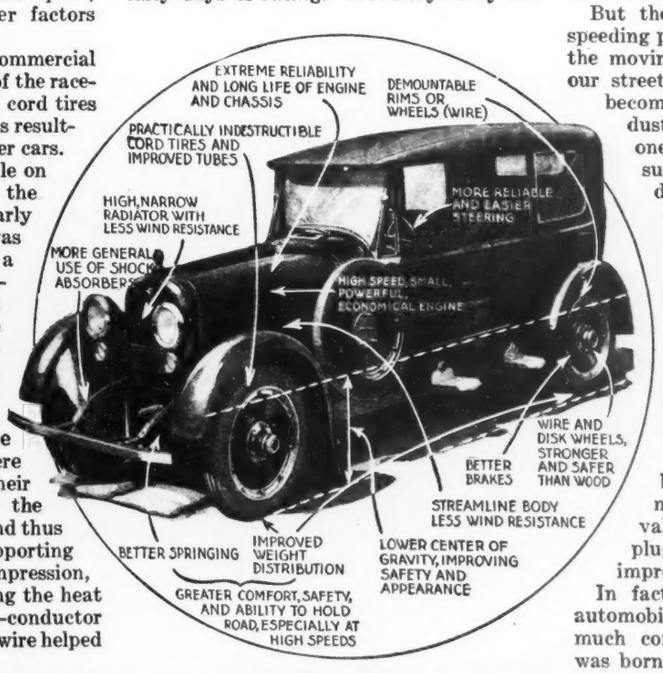
Racetrack Gives Cars Grueling Test

De Palma shrugged his shoulders. "The luck of the racetrack," he called it.

But the "luck" of De Palma and his speeding pals has resulted in strengthening the moving parts of every automobile on our streets and highways today. It has become an axiom in the automobile industry that if any part survives one of the grueling auto races, it will survive anything, and that if it does not survive, it is not safe enough for a stock car. Engineers figure that the stress and strain of a 500-mile race is equal to the wear of 50,000 miles of ordinary driving.

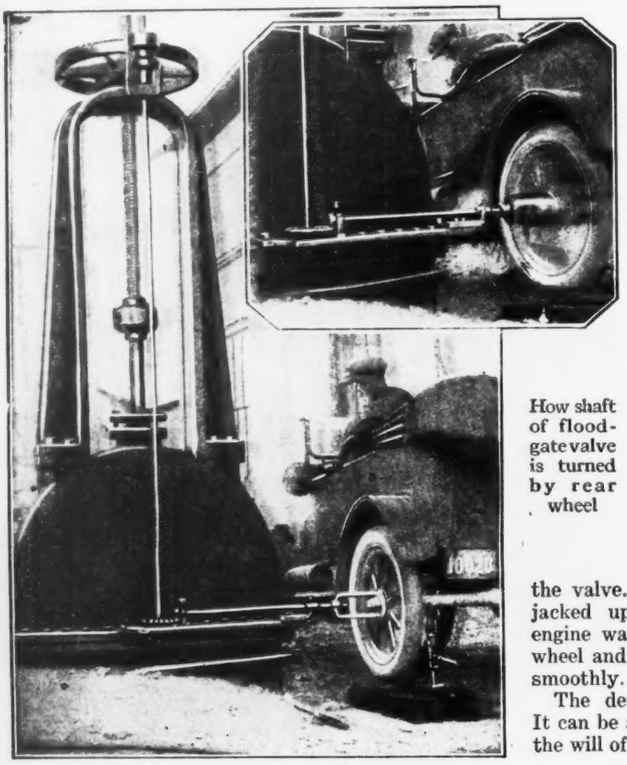
I could go on almost indefinitely enumerating improvements now common to commercial cars that originated on the speedways—the high, narrow radiators, first designed to cut down wind resistance, streamline bodies, pressure lubrication, the more general use of overhead valves, shock absorbers, better spark plugs, better springs and brakes and improved ignition.

In fact, I may safely say that the automobile you are driving now with so much comfort and assurance of safety was born in the roar of flashing cars and reared under the firm hand of smiling, grimy-faced speed kings in the hard school of the automobile speedway.


EXTREME RELIABILITY AND LONG LIFE OF ENGINE AND CHASSIS
DEMOUNTABLE RIMS OR WHEELS (WIRE)
PRACTICALLY INDESTRUCTIBLE CORD TIRES AND IMPROVED TUBES
MORE RELIABLE AND EASIER STEERING
HIGH, NARROW RADIATOR WITH LESS WIND RESISTANCE
MORE GENERAL USE OF SHOCK ABSORBERS
HIGH SPEED, SMALL, POWERFUL, ECONOMICAL ENGINE
WIRE AND DISK WHEELS, STRONGER AND SAFER THAN WOOD
BETTER BRAKES
STREAMLINE BODY LESS WIND RESISTANCE
BETTER SPRINGING
IMPROVED WEIGHT DISTRIBUTION
LOWER CENTER OF GRAVITY, IMPROVING SAFETY AND APPEARANCE
GREATER COMFORT, SAFETY, AND ABILITY TO HOLD ROAD, ESPECIALLY AT HIGH SPEEDS

Important improvements of the modern automobile that can be traced directly to the motor speedway

Automobile Drives Hydraulic Valve



How shaft of floodgate valve is turned by rear wheel

ADD one more use to the useful automobile.

At Lovelocks, Nev., the Nevada Valleys Power Company operates a power house at which one of the 48-inch floodgate valves is seldom used. For this reason no electric drive is provided.

But the superintendent owns an automobile, and that auto solved the power question.

A U-shaped piece of metal was fitted over the hub of one of the rear wheels and fastened to the spokes. This piece in turn was fastened to a pinion-gear shaft operating the valve. Then the wheel was jacked up and the automobile engine was started, spinning the wheel and turning the gear shaft smoothly.

The device worked perfectly. It can be attached or detached at the will of the operator.

Rainmaking Airplanes for Montana

ON THE heels of the recent rainmaking experiments at McCook Flying Field at Dayton, Ohio, where airplanes succeeded in annihilating clouds and causing precipitation by spraying clouds with electrically charged sand, comes the report that Richard T. Ringling, member of the famous circus family, has purchased 10 airplanes to be used by professional rainmakers in Montana's dry land farming district.

Ringling announces that these planes, assembled at Great Falls, Mont., will make regular trips to various sections of the state, discharging positive and negative ions of electricity into the air from a wing of the machine, as it speeds through the air, to form the nuclei of clouds. An attempt then will be made to precipitate the clouds thus formed by spraying them with electrically charged sand.

This process, developed by Dr. Wilder D. Bancroft, professor of physical chemistry at Cornell University, and L. Francis Warren, was described on page 29 of the May issue of POPULAR SCIENCE MONTHLY.

Reports from the Weather Bureau at Washington, D. C., indicate the belief of officials that while rainmaking by airplanes may be possible over limited territory, its broader application is doubtful.

World's Largest Wrecking Crane

WHAT is said to be the world's largest wrecking crane is in operation on the Virginia Railway. This huge machine can lift a load of more than 401,940 pounds, for a radius of 17½ feet.

Comparison of this lifting power with that of a human being gives an idea of the tremendous strength of the machine. An average man can support a load of about 20 pounds at arm's length, the equivalent of holding slightly more than two pounds at 17½ feet. The crane would therefore appear to have the strength of 200,000 men.

Lifting a weight of 401,940 pounds with powerful steel arm

New Radiator Funnel Prevents Spilling

A NEW automobile funnel that fits snugly into the radiator inlet and stands erect by itself has been invented to take the place of the old style funnel that had to be held.

This novel device permits the use of both hands in pouring water. In addition, it is rigid enough in its position to support the weight of a pail of water on its edge, thereby lessening the exertion of holding the pail clear at radiator height.

Both hands are free for pouring

In winter most people empty the radiator every night to prevent freezing, and this necessitates refilling with hot water. Use of the new funnel eliminates the danger of soiling clothes or burning the hands with spilled water.

The funnel has a brass screen strainer that prevents any refuse from entering the radiator. Spouts are made in various sizes to fit any car or truck. Each spout has a small groove to provide space for the overflow pipe in the radiator inlet.

Novel Fountain Pen Used to Eradicate Ink

TO ERADICATE ink, it is no longer necessary to perform a complicated experiment in chemistry, for the invention, by Thomas W. Cappon, of Newark, N. J., of a fountain pen containing a fluid has provided a simple means of erasing.

The fluid is stored in a glass tube inserted in the fountain pen. A movable glass plunger sliding loosely in a cork stopper keeps the liquid in the tube. By pressing this plunger down on the paper, a small amount of the fluid can be forced out; then, by means of a round knob at the extremity of the pen, the fluid is spread over the writing to be obliterated.

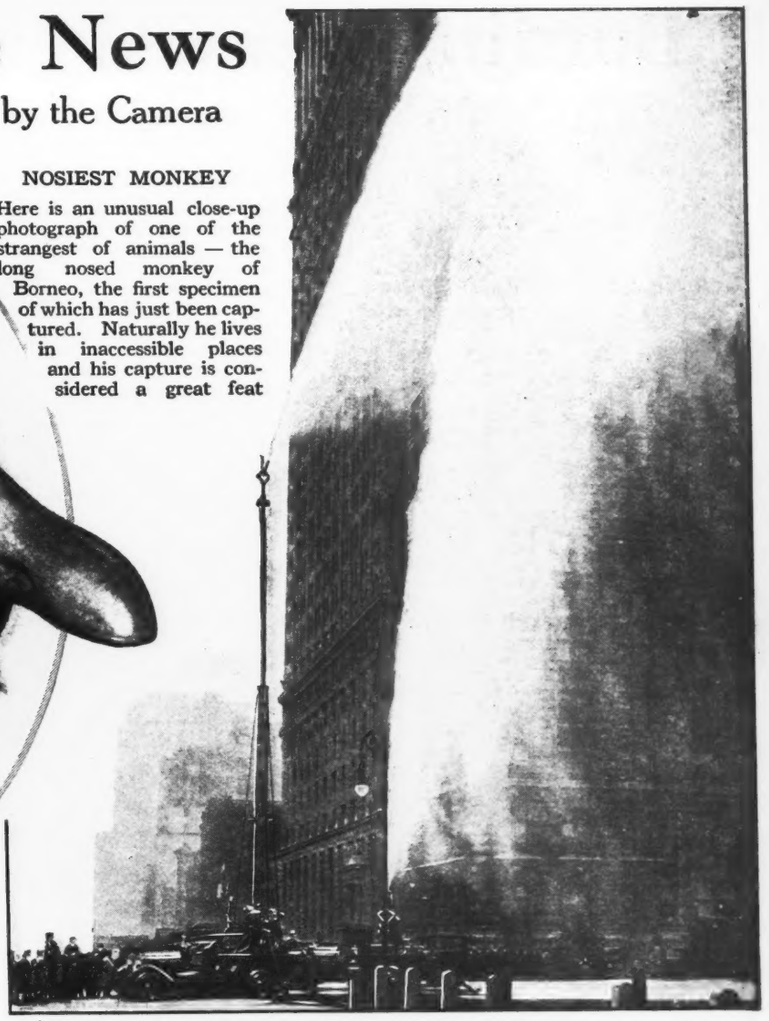
The erasure is said to be complete. When the paper has been dried with a blotter, it is possible to write on it without fear of smudging.

Oddities in the News

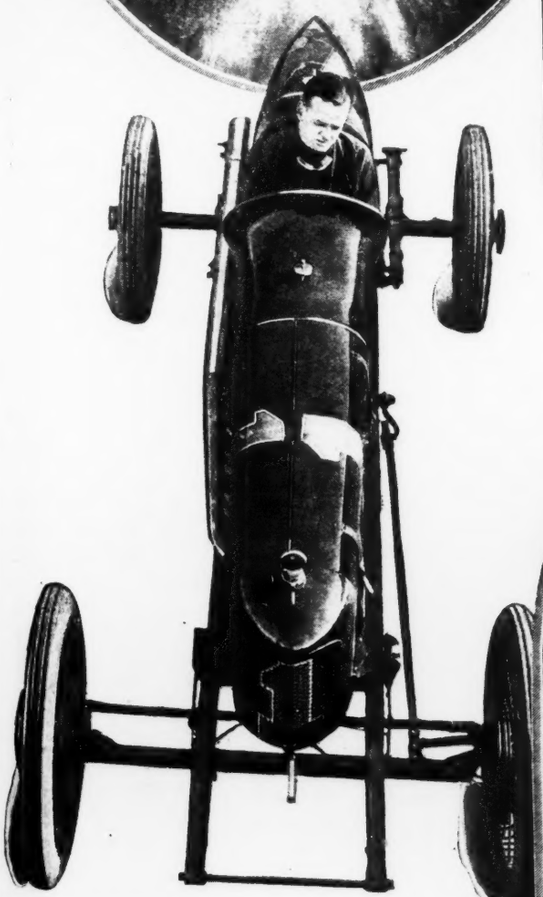
World's Queerest Monkey Caught by the Camera

NOSIEST MONKEY

Here is an unusual close-up photograph of one of the strangest of animals — the long nosed monkey of Borneo, the first specimen of which has just been captured. Naturally he lives in inaccessible places and his capture is considered a great feat



NEW YORK CITY'S TALLEST WATER TOWER in action in the skyscraper district. It rises 65 feet above the level of the street, enabling fire fighters to direct a powerful stream into the eighth floor of a building



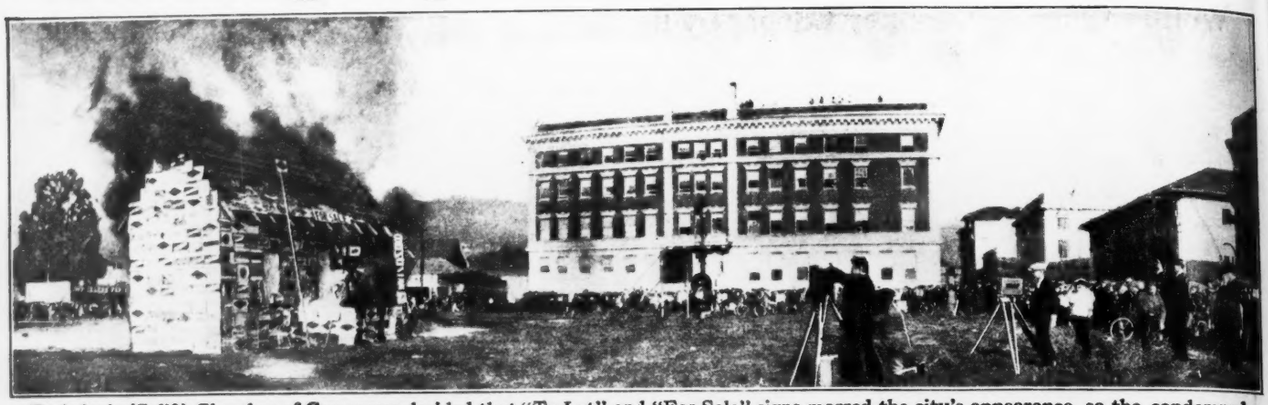
TOMMY MILTON DRIVES MIDGET RACER

It looks like a toy; but this latest creation of the famous speed king can travel 100 miles an hour. It's the smallest car capable of such speed—a 122 cubic inch, one man racing car, weighing only 1350 pounds, or 750 pounds less than the present 183 cubic inch racers. The frame is only 21 inches wide. The streamlined body looks like a bass horn

© Keystone

WHY GET STUCK IN THE MUD when you can walk on top of it with homemade mud shoes? This inventive Californian has made his out of square boards that are fitted to his feet like snowshoes. To protect his trousers he has added burlap skirts that hang from his knees to the edges of the boards. A mudproof wheelbarrow similarly shod and having a barrel for a wheel completes the ingenious outfit

Burning Up Old "To Let" Signs



Berkeley's (Calif.) Chamber of Commerce decided that "To Let" and "For Sale" signs marred the city's appearance, so the condemned boards were nailed together in the form of a house, the torch was applied, and the ugly signs went up in smoke

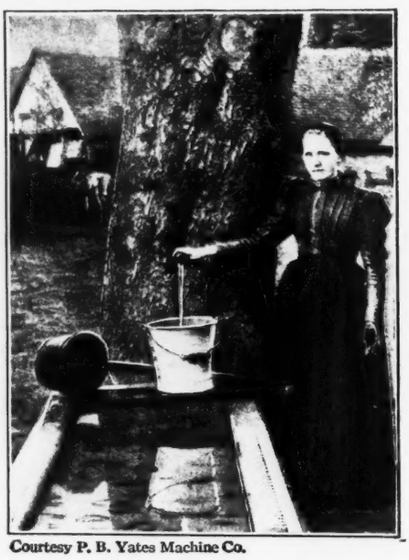
Natural Spring Bubbles from Tree

ON A small farm near Bern, Switzerland, can be found a large tree from which water gushes.

At first glance the spring may seem to be an artificial arrangement. Instead, it is simply still another of Nature's curious little freaks.

Not until the tree had attained a considerable growth was there seen any indication of a spring. Then, through a crevice in the side, a little water trickled out. This stream became larger as time went on, until now enough cool, clear water pours out to supply all the needs of the farm, and since the farmer built a trough under the spring, the cattle have made a well-worn path there.

No one can explain just how the spring originated. It is possible that the roots of the growing tree pierced a subterranean stream and that the rising water found least resistance when it passed up through a hollow portion of the tree and then out through a crack in the side.



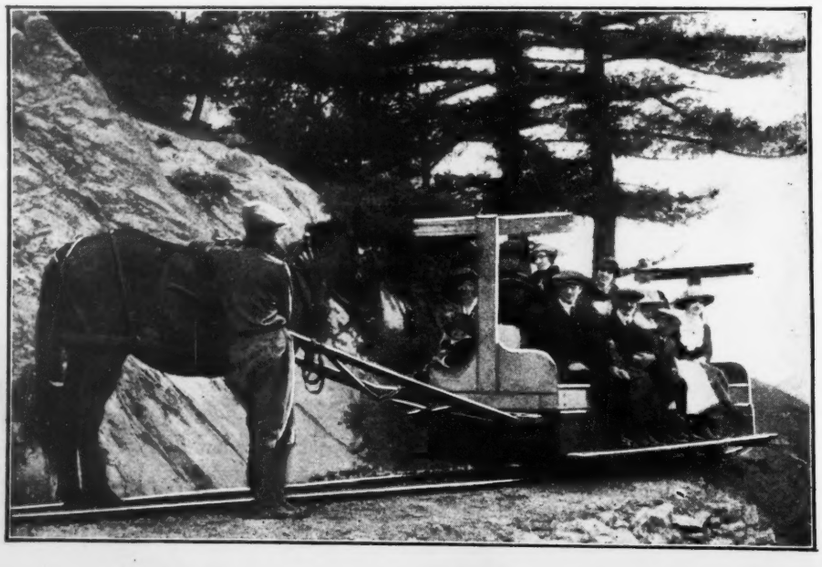
Courtesy P. B. Yates Machine Co.

One Mulepower Pushes Railway Car

MOUNT LOWE, Calif., which overlooks a panorama of rare beauty, boasts of a scenic railway along which a car, propelled by a mule, carries sightseers up the steep route for a view of the magnificent scenery.

The railway was built single-handed by a young man who went to the mountains to regain his health.

The car has two longitudinal seats, back to back, which will accommodate 16 passengers. To protect the passengers from the dust kicked up by the mule, the animal is hitched behind the car as shown below.



California Sunflower Grows to Record Height

AS IF to further substantiate California's claim as the state where things assume record breaking magnitude, Miss Margery Bush, of Petaluma, has grown what is probably the world's tallest sunflower. It was grown in the back yard of her home and measured 15 feet from the root to the top of the flower.

While Luther Burbank has been producing sunflowers a foot high so that they may be consumed by poultry without the necessity of harvesting the large seed-bearing caps, Nature has been working in the opposite direction, as shown in this case.

It is not generally known that several European countries cultivate sunflowers for economic purposes—the leaves being used for cattle fodder, the seeds for food and for oil, which is considered equal to olive or almond oil, and the flowers for the yellow dye that they yield.

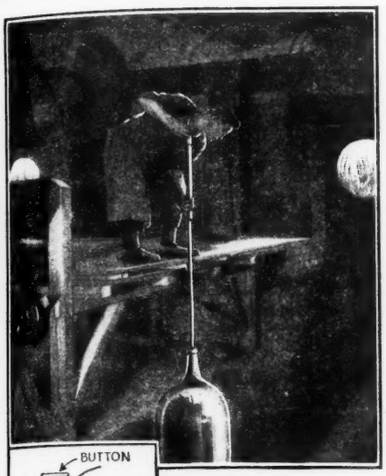
© U.& U.

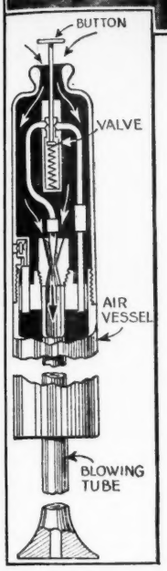
The World's Deepest Mine

THE deepest mine in the world, the St. John del Rey gold mine in Brazil, penetrates the earth for more than 1¼ miles. At this depth the temperature of the rock is 117° F., necessitating an elaborate system of artificial cooling.

The great operating problem is the high cost of ventilating and hoisting through a steplike series of shafts and levels by which the bottom slopes are reached.

Mechanical Lungs for the Glassblower





THE first successful equivalent of glassblower's lungs recently was invented.

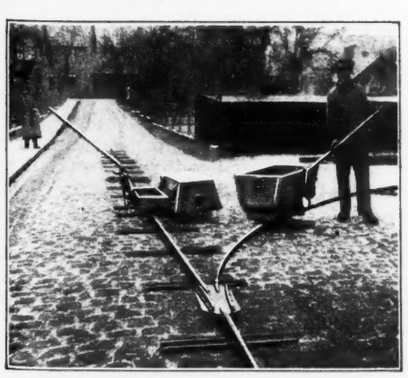
Pressure on a button provides sufficient air in proper velocities to enable the glassblower to perform the most delicate work mechanically.

The button controls a valve in a line leading from a compressed-air chamber. Air passing this valve, shoots into an injector and sucks with it an equal amount of air from the outside. The combined jet of air then passes through a blowpipe.

Hand Cart Wheelbarrow Rides Monorail

A MONORAIL hand cart, designed to replace the wheelbarrow, recently has been invented in Germany, where it is finding extensive use in street railway work.

The car has two wheels each equipped with a double flange. To the frame is attached a long handle with which the operator keeps the car upright and against which he pushes. The wooden box, which has a capacity of about eight cubic feet, is mounted on hinges so that it may be tipped to one side when depositing the load.



Pushing hand cart along monorail

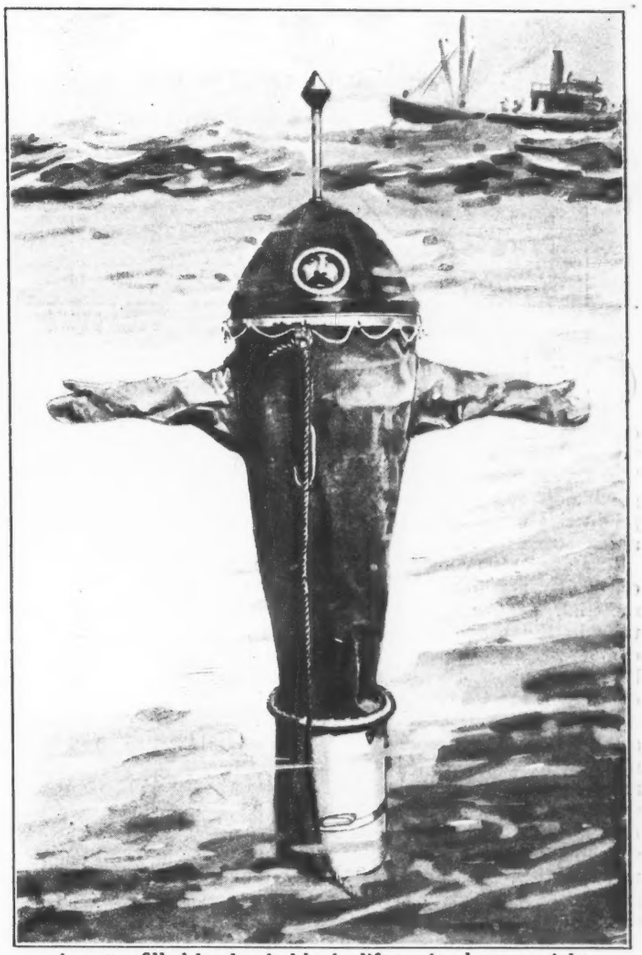
Shipwreck Victim Floats in Buoy

A UNIQUE life-saving apparatus, termed the "skittle peg" by its inventor, a Finnish fisherman, is actually a miniature buoy, large enough to inclose a person standing upright.

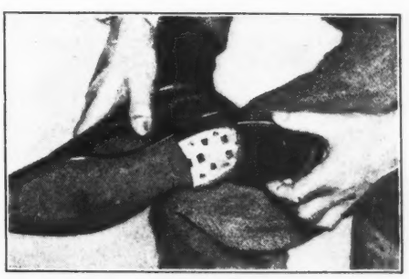
It consists of a watertight bag with two sleeves, a bucket at the base and a hood that is provided with a window through which the shipwrecked occupant may look out. The occupant stands on a platform above the bucket.

When in the water, the bucket fills and this weight keeps the bag upright. The watertight sleeves of flexible rubber permit limited motion on the part of the occupant if he attempts to swim.

The air tube at the top extends sufficiently above the surface to permit breathing. Surmounting the tube is a brightly colored cone shaped signal that helps rescuers to locate the victims of a sea disaster.



A water-filled bucket holds the life-saving buoy upright



New Heels for Old Shoes Attached by Hand

DETACHABLE leather heels recently have been invented to afford rapid and inexpensive replacements for worn heels. The upper part of the heel is screwed firmly to the shoe and has a number of lugs that hold the detachable base. Any one can remove the old heels and put on new ones in a few minutes.

Indoor Gardens Grow from Waste Fruit Seeds

AN INDOOR garden that will provide a plentiful supply of table plants can be obtained from fruit pits usually thrown away by the cook. Date stones are excellent for this purpose. Place a number of the stones in a jar of water and soak them for a week; then plant them in a pot filled with rich soil. In a warm room the little date palms will grow quickly.

Plants can be grown easily from grapefruit, orange, and lemon seeds.

Road Sign Maps Answer Tourists' Questions

AUTOMOBILE road signs that anticipate tourists' questions and answer them have been placed at the six main approaches to the city of Madison, Wis. The signs have proved helpful to dozens of parents driving in from distant points to visit their sons and daughters at the University of Wisconsin.

The signs show all the principal points of interest in the city and direct the tourist to these points, which include the university, the state Capitol, lakes and parks, the post office, railroad stations, and trunk highways.

This roadside map directs the tourist

Making Hay while the Rain Pours

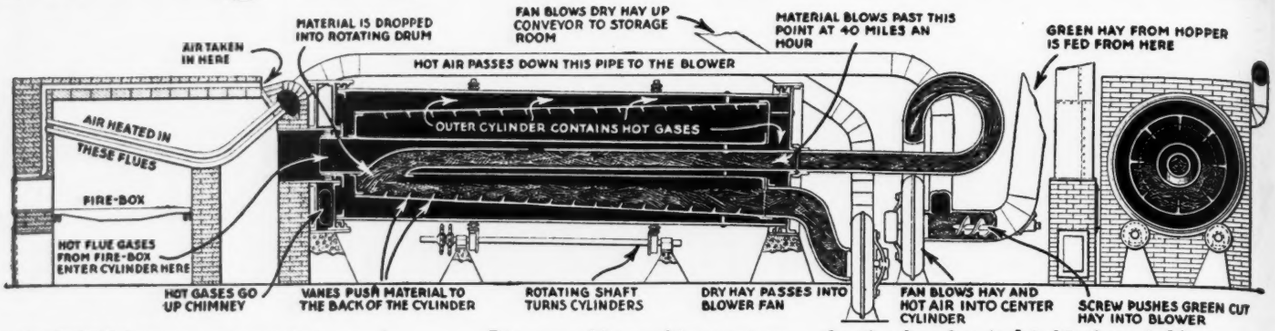

AIR TAKEN IN HERE
MATERIAL IS DROPPED INTO ROTATING DRUM
FAN BLOWS DRY HAY UP CONVEYOR TO STORAGE ROOM
MATERIAL BLOWS PAST THIS POINT AT 40 MILES AN HOUR
GREEN HAY FROM HOPPER IS FED FROM HERE
HOT AIR PASSES DOWN THIS PIPE TO THE BLOWER
AIR HEATED IN THESE FLUES
OUTER CYLINDER CONTAINS HOT GASES
FIRE-BOX
HOT FLUE GASES FROM FIRE-BOX ENTER CYLINDER HERE
HOT GASES GO UP CHIMNEY
VANES PUSH MATERIAL TO THE BACK OF THE CYLINDER
ROTATING SHAFT TURNS CYLINDERS
DRY HAY PASSES INTO BLOWER FAN
FAN BLOWS HAY AND HOT AIR INTO CENTER CYLINDER
SCREW PUSHES GREEN CUT HAY INTO BLOWER

Diagram of haymaking apparatus, showing how hay is dried by hot-air blast

CURING green, water-soaked grass in five minutes is the remarkable feat claimed for a haymaking machine designed on an entirely new principle, invented by Nuna C. Hero, of New Orleans. The inventor predicts that it will take the gamble out of haygrowing, and increase the productive capacity of present hay lands about 50 per cent.

The apparatus consists of a dehydrating or drying machine, in which the green material, passing through an eight-inch tube in the center of a large rotating cylinder, is subjected to a powerful hot-air blast. The small tube discharges into the cylinder at the far end.

Running the full length of the cylinder is a series of fins inclined so as to discharge material toward the back, as the cylinder revolves. Around the eight-inch tube within the cylinder are hot-air jackets connected with each other. Smoke and waste heat of the furnace are sent through these jackets, heating the air in the tube and keeping the hay at an even temperature.

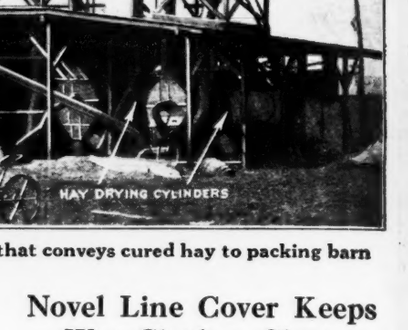
When the green material has been hauled to the dehydrator, it passes first through an ensilage cutter, which chops it into short lengths. From there, it is elevated, by belt, to a point where a blast of air, at 300 degrees temperature, drives it through the eight-inch tube at the rate of 40 miles an hour, and out into the revolving cylinder.

As the material is worked along by cylinder fins, the wind picks up what has become perfectly cured and blows it into a suction pipe, in which it is conveyed into the packing barn. There it is packed into sacks holding 50 pounds. The entire operation takes five minutes—from ensilage cutter to packing barn.

The haymaking plant. Note suction pipe that conveys cured hay to packing barn

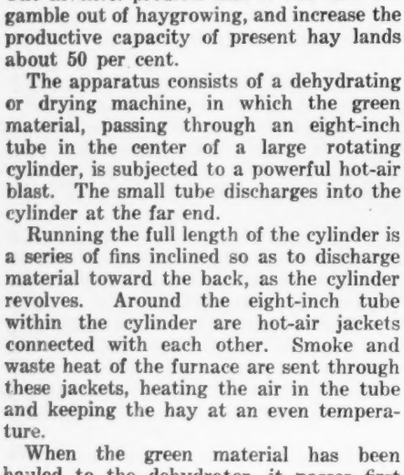
Novel Line Cover Keeps Wet Clothes Clean

A LINE cover operated in a spring reel, designed to do away with the soiling of newly washed clothes by a dirty line, has been patented by a housewife who lives near a railroad. She wearied of doing her week's wash over a second time because the line had been soiled by smoke from passing trains.



Taping line as clothes are hung

Covering the line with strips of cloth gave her the idea for her invention, which consists of a long tape wound on a spring reel that is adjusted so it rides on the line. Entering the reel, the tape is creased so that the soiled surface next to the line is folded upon itself, only the clean sides coming in contact. The device is operated by pinning one end of the tape to the line and running the reel along as the clothes are hung.



Steel Window Guard Keeps Burglars Out, Baby In

EVERY mother who has worried for fear her baby will fall out of a window will be interested in a new removable window guard made of steel bars strong enough to keep burglars out and baby in. It may be taken from room to room as needed and folded away when not in use.

After a channel bar for holding the guard is screwed into the frame of the window, no screws are visible.

The locking device covers all screws so that they cannot be located for removal from the outside.

Folding Steel Horse for Use about the House

FOR the man without a workbench, who now uses the piano bench or kitchen chair as a sawhorse, an inexpensive folding steel horse recently has been invented. It may be used as support for temporary workbenches, display tables, banquet tables or platforms. It also has a clamp attachment that serves as a vise.

When folded, the new horse occupies a space 4 by 5 inches by the length of its beam. It may be kept in a carpenter's tool chest or in a closet.

When folded, the steel horse fits the tool chest or closet

FOREST fires in the United States average 33,500 annually, reports the United States Forest Service. More than 7,000,000 acres are burned each year, with a property loss of $16,424,000.

Beetles Eat Telephone Lines

Lead-Boring Bugs Cut and Ruin Miles of Electric Cable in California

WHEN lead fuses blow out on electric light and power lines in California, it is not always due to a short circuit, but often to a lead-eating beetle that penetrates the metallic covering of the fuse and eats away the lead.

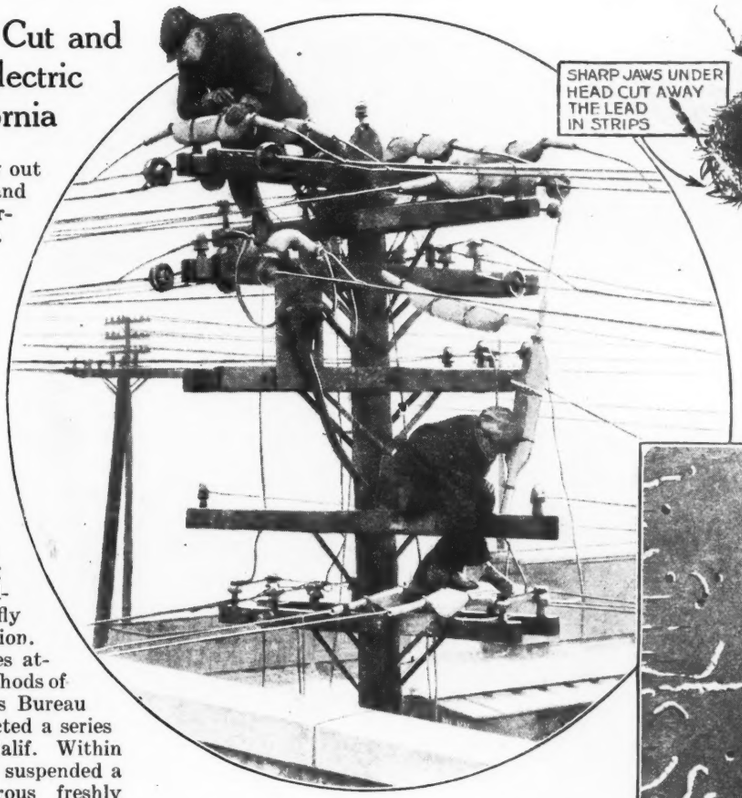
This beetle, scientifically known as *Scobica declivis*, also has destroyed many miles of lead cable covering for telephone lines. The insect lays its eggs in holes that it bores in trees and telephone poles. In these holes the young pass through the larva and pupa stage, emerging as full fledged beetles the following year. Then they fly away on careers of destruction.

To find out why the beetles attack metal and to discover methods of prevention, the United States Bureau of Agriculture recently conducted a series of experiments at Los Gatos, Calif. Within two large screened cages were suspended a number of cables. Numerous freshly emerged beetles were placed in the cages.

The experiments showed that practically all the boring was done near the contact between the cables and the suspension rings. The reason for this, it was found, is that the beetle requires a foothold from which to attack the cable. Such a hold it obtains by bracing itself against the ring. The holes, about one tenth of an inch in diameter, permit the entrance of water, which short circuits the wires within.

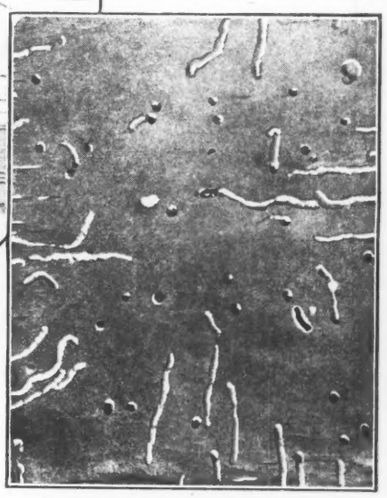
The female beetles do most of the boring, in locating places in which she can lay her eggs. As a preventive, the cables are coated with beef tallow, which sticks to the beetle and suffocates it when it tries to bore.

There are other similar insects that cause appreciable damage to metals. Both in Europe and America there are beetles that eat the quicksilver off the backs of mirrors and still others that devote their energies to removing gilding from chandeliers.



California linemen wrapping cables with tallow as protection from boring beetles

With sharp pincer jaws, the lead borer shown above eats away the lead covering of fuses and cables

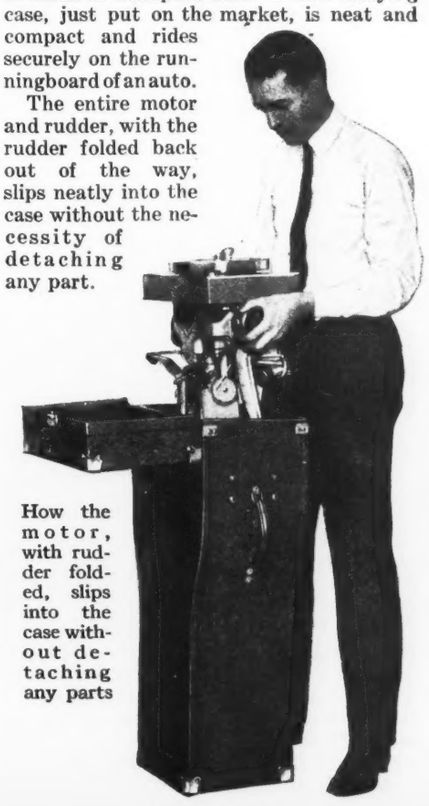


A typical piece of lead cable covering after an attack by beetles

Rowboat Motor Travels in Carrying Case

THE detachable rowboat motor now may take its place with typewriters, stenotypes, and other portable machines in mode of transportation. A new carrying case, just put on the market, is neat and compact and rides securely on the runningboard of an auto.

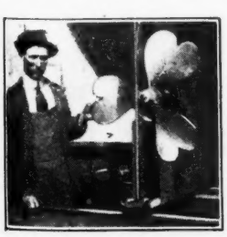
The entire motor and rudder, with the rudder folded back out of the way, slips neatly into the case without the necessity of detaching any part.



How the motor, with rudder folded, slips into the case without detaching any parts

New Cloverleaf Propeller Said to Increase Speed

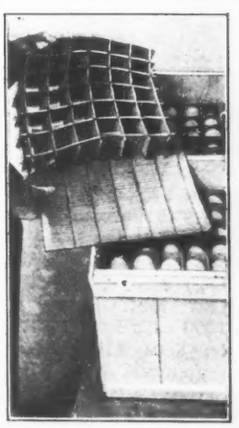
A NEW type of propeller, adaptable to any size craft, and said to have increased efficiency, due to its queer cloverleaf form, is coming into use on the Pacific coast.



Its widened blades, it is claimed, present about twice as much surface to the water during one revolution, and produce greater speed than any other propeller of the same size and pitch. The time required to reverse a boat is considerably lessened, it is said.

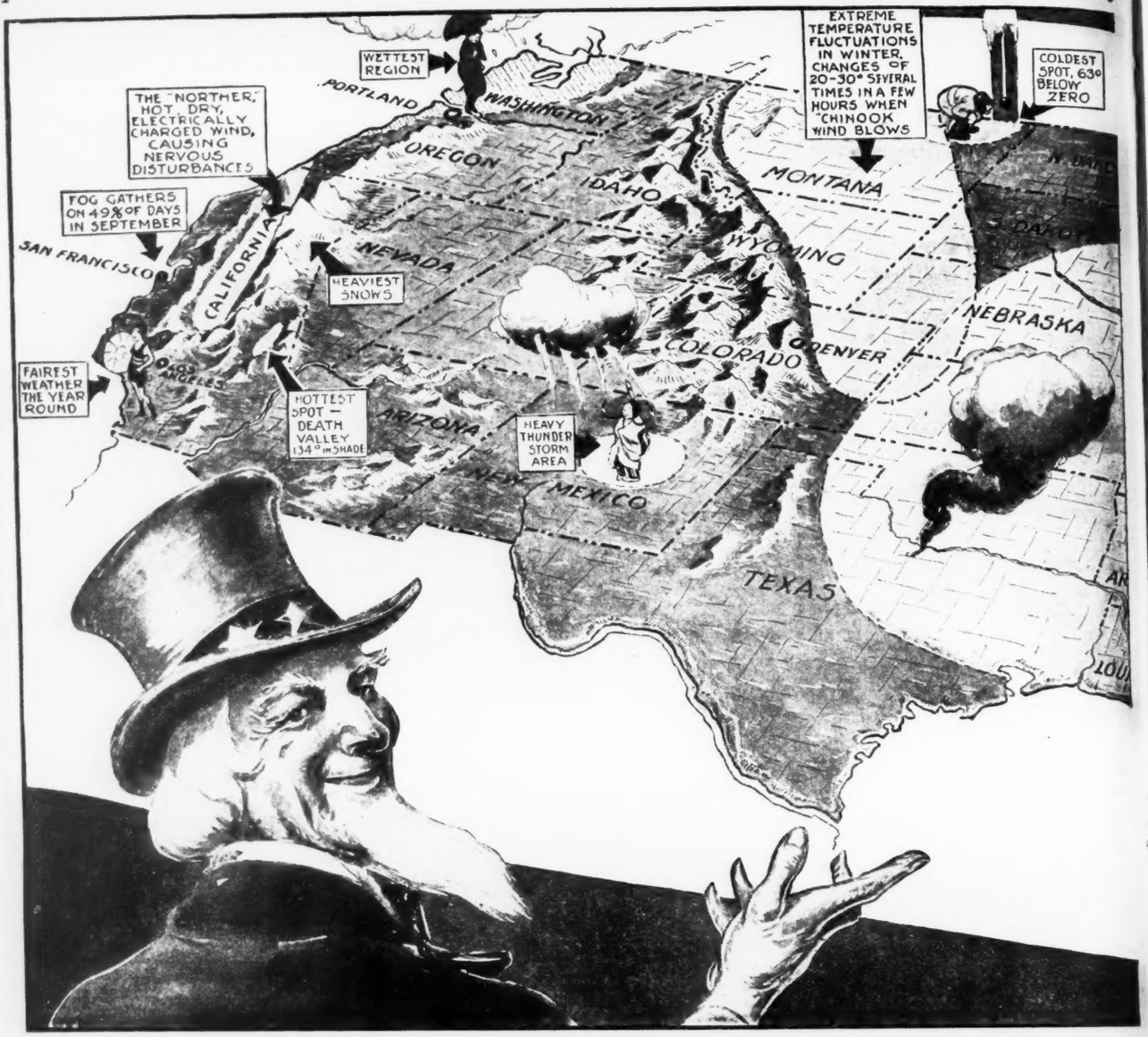
Eggs Locked and Padded for Safe Shipment

EVERY farmer, freight handler, and commission man engaged in handling eggs will welcome the invention of a new cushion locked pad for egg crates, which is said to reduce breakage to the minimum. The honeycomb containers are made of light cardboard and are backed by a corrugated strip of padding for each row of eggs.



A corrugated pad keeps eggs from slipping

These strips provide cushions between the layers of eggs. They also lock the honeycombed filler sections tight, preventing slipping as the cases are handled. Continual sliding on the smooth cardboard pads in common use is said to be the cause of a large percentage of breakage in transit. With the new pad each egg is locked and padded in its own compartment. It is reported that shipments packed in this manner, greatly reduced loss by breakage.



The Truth about the Weather

Told to Robert E. Martin *by* James H. Scarr

New York District Forecaster of the U. S. Weather Bureau

SOME 20,000 individuals ask me questions about the weather every year. Weather questions pour into our New York office over three trunk telephone lines at the rate of one a minute on ordinary days. At the first gust of an approaching storm, the calls often mount to 10 a minute. On such days, the telephone company reports that within eight hours as many as 1500 calls have failed to reach us because our lines were all busy.

And while we are trying to answer these innumerable questions over the phone—while we are telling one man whether the moon shone a week ago last Thursday, and another that we can't possibly predict how much rain will fall day after tomorrow—other people, gathered in the office, are asking the weather man for personal help in solving their business and domestic problems.

A widow came in the other day to inquire what city she should move to in order to save her son from recurrent attacks of pneumonia. An excitable husband was waiting to ask if there was any place in the country where thunderstorms never occur. He said he wanted to move there, because during every thunderstorm his wife kept him awake all night with her terrorstricken complaints. Next him was a young business man who said he dyed straw for straw hats and wanted help in determining just what conditions of temperature and humidity would be best to make his process effective.

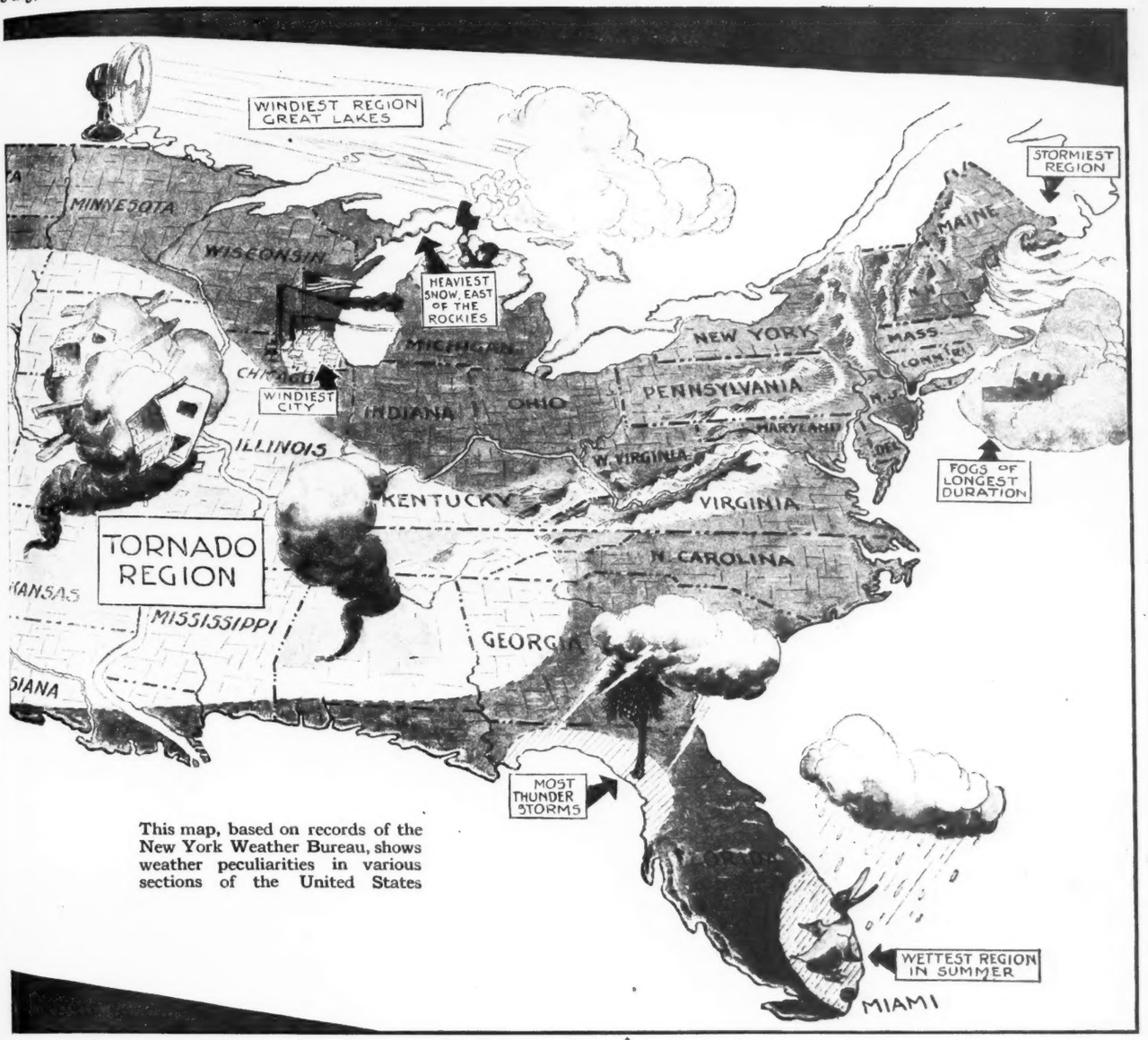
Meanwhile the flood of telephonic inquiries continued. Fool questions? Not a bit of it! Earnest, honest-to-goodness inquiries that help to regulate every human activity or interest, from washing to weddings, from food crops to street cleaning, from week-ends to wearing apparel, from coal supply and construction to advertising and after-theater suppers.

Every Friday afternoon in spring we are bombarded with feminine voices over the telephone asking about the week-end forecast. It seems as though nearly every office girl in town who has access to a telephone is anxious to know whether she can safely plan a Saturday afternoon excursion.

A worried Brooklyn housewife wants to know whether it will be safe to have her laundress come tomorrow, "or will it rain?" A timid young woman pays me a personal visit to inquire whether the weather will be auspicious for her wedding next Wednesday.

Among all these hourly proofs that Mr. Average Citizen finds the weather man a constantly useful assistant in his daily affairs, the question that crops up most frequently is whether the winters aren't getting warmer and the summers cooler than they used to be. This seems to be a universal popular belief. I has prevailed in every adult generation for centuries, and is continually cropping up anew.

Only last winter, Chicagoans began to lay claim to a milder climate than they used to have. They alleged that the city is now enjoying the warmer winters characteristic, 20 years ago, of regions 250 miles farther south. And yet the most conclusive weather bureau figures prove that over a period of many generations *the climate of the United States hasn't changed in a single distinguishable item.*



This map, based on records of the New York Weather Bureau, shows weather peculiarities in various sections of the United States

"Well, but I *know* the snowdrifts were higher when I was a boy," a friend of mine said to me the other day, "and the blizzards were lots fiercer; while I can remember glorious skating days unequalled by anything the youngsters have now."

"How tall were you as a boy?" I asked in reply. "Just remember that snowdrifts that now only reach your knees, used to reach above your waist. The drifts weren't a bit higher, but they looked like mountains to you then. And your memory is the most deceptive thing you have. One or two isolated blizzards stand out spectacularly in your mind and color your impression of whole winters. The youthful glamour around a few days of fine skating has so grown upon you in recollection that you forget the innumerable days of thaw."

Perhaps the American people discuss the weather so continually because more weather freaks and more extremes of climate affect the United States than any other great nation on the globe.

A single one of our states—California—can boast that it harbors, almost side by side, the hottest spot on earth, the pleasantest year-round climate, and the heaviest snowfalls in the country. Up in the northwest corner of the map, around Puget Sound, America's rainiest cities thrive, while in the opposite corner, New England rises to confess that she is stormier, foggier, and more afflicted with cold waves than any other part of the land.

The coldest spot in the country is Poplar, Mont., where the temperature has been 63 degrees below zero in January.

At the other end of the thermometer stands the sizzling high mark of 134 degrees in the shade, officially noted on the weather bureau instrument at Greenland Ranch, Death Valley, Calif. If the temperature should rise to any such point as that in the more humid portions of the country, the population would be pretty nearly wiped out overnight.

Outside the extreme northern portions of the United States, between the Rockies and the Great Lakes, the coldest winters are experienced in the region around Ogdensburg, N. Y., and thence eastward to Lake Champlain, northern Vermont, New Hampshire, and Maine. There a temperature of 40 below zero has been recorded.

Weather Bureau records beginning in 1871 show that no spot on the mainland of the United States has wholly escaped freezing weather; Key West alone has been frostless. Zero weather, however, never has touched the Pacific Coast, although it has reached as far south as the gulf coast of Mississippi and Louisiana.

Minneapolis, St. Paul, and Duluth are the largest cities that enjoy 'way-below-zero temperatures, and they likewise are the largest cities with a pronounced annual range in temperature covering more than 100 degrees. The greatest yearly range in

(*Turn to page 56*)

Is Our Climate Changing?

OFTEN we hear oldtimers say that our winters "ain't what they used to be"—that we no longer have the fierce blizzards, the bitter cold that we did "when I was a boy." Most of us have thought the same thing.

Is it really true that the earth is growing hotter? Or is it growing colder?

A few years ago science held to the theory that the earth, a big heated ball, was gradually cooling off. Today scientists, in their study of radium, are investigating a theory that the earth actually may be growing warmer under the influence of radioactive forces.

Which is right?

"The most conclusive Weather Bureau figures," answers James H. Scarr, famous New York weather forecaster, "prove that for many generations the climate of the United States hasn't changed in a single distinguishable item."

Read what he says about it in this article.

Hunting Big Bustards by Airplane

THIS picture shows a thrilling moment in the newest air sport—hunting the great bustard, Europe's largest bird, by airplane. This sport was originated recently by Spanish aviators attached to an airdrome on the southern plains of Spain, where the huge birds are plentiful.

The great bustard, of the species of long shanked wading birds, is found in Europe in small flocks of eight or 10. The largest of the males weigh from 30 to 42 pounds, are four feet long, with a wing spread of six or seven feet. Because the birds are unusually timid and suspicious, it was extremely difficult to bag them until their new enemy, the airplane, appeared.

One of the Spanish aviators, Lieutenant Lecea, recently conceived the idea of running down a flock of bustards, separating one bird from the group, and of pursuing that bird until he tired it out and forced it to land. This was soon followed by a new phase of the sport—driving an airplane into a flock as soon as the birds rose, and shooting at them from the cockpit of the machine. Hunting of this kind requires skill, for the gunner is hampered in his shots by the limited horizontal range of the gun, due to the ties and struts of the machine.

About the Weather

(*Continued from page 55*)

temperature is in eastern Montana and the western part of the Dakotas. Residents of Huron, S. D., have seen their thermometers cover a range of 151 degrees in a year.

Among the great cities of the country, the average monthly temperatures during a year is lowest in San Francisco, and highest in St. Paul. San Francisco's average monthly temperature is 50 degrees in winter and 60 degrees in summer.

The driest portion of the country is the region of Death Valley, while the driest big cities are San Francisco and Los Angeles, which are rainless in July and August. The maximum monthly rainfall in Los Angeles is three inches—in December—while in Astoria, Ore., Jupiter Pluvius lets loose as much as 13 inches of rain in one month.

When it comes to thunderstorms in these rainy cities of the Northwest, they occur at the rate of only about two a year; while right around the mouth of the good old Suwanee River, in northwestern Florida, is the champion thunderstorm region of the land. Ninety thunderstorms a year are the average in this region. Farther south, Miami is treated to the rainiest summer climate in the country.

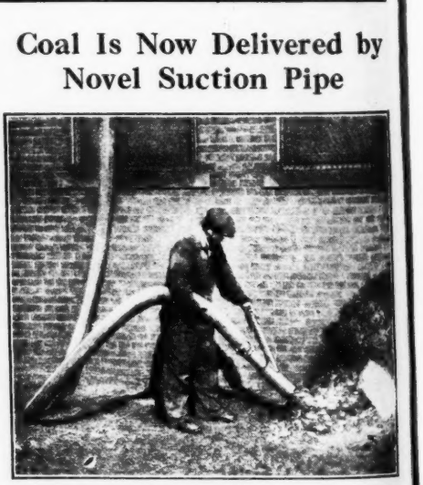
The snowiest region in the United States is on the Sierra Nevada and Cascade ranges, where snow 30 feet in depth has been noted. Northern Michigan has the heaviest snow outside of the Western mountains. Here a snowfall of over 100 inches a winter is not uncommon, as compared with less than half that average around New York City.

The extreme northeast coast of Maine is the foggiest part of the United States; here there are an average of 1600 hours of fog a year; while the famous San Francisco fogs, which sweep in as regular as clockwork in the summer, total about 1100 hours a year.

Besides being the foggiest, the New England coast is the stormiest part of the country. The region of the Great Lakes and the Western plains are the windiest in the interior. Chicago, in the heart of the Great Lakes region, lives up to its name of the Windy City by reporting the high average annual wind velocity of 16 miles an hour, as compared with an annual average velocity of four miles an hour at Lynchburg, Va.

St. Paul is credited with the highest wind velocity ever reported over a five-minute period—102 miles an hour. One of the outstanding tornadoes of American history struck St. Louis on May 27, 1896, when the velocity of the wind is said to have exceeded that of a rifle bullet.

Coal Is Now Delivered by Novel Suction Pipe



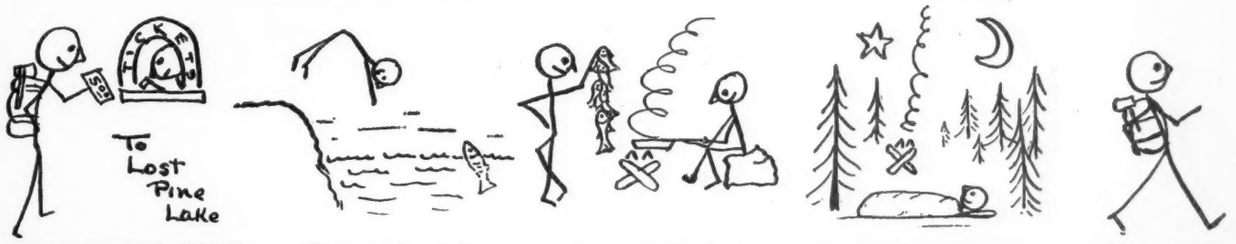
A MANUFACTURER from the Middle West thought of using the vacuum principle for delivering coal. The mouth of the suction pipe is placed at the edge of a heap of coal, which is literally sucked to its destination, whether it be from the street into a house cellar or from freight train to coal wagon.

Of course, only small coal can be disposed of by this method. One man can handle 20 tons of fine coal an hour.

Your Vacation—How to Make It Pay

Noted Health Expert Prescribes the Ideal Scientific Summer Outing, Especially for Young Men, to Rebuild Worn Parts of Mind and Body

By C. Ward Crampton, M.D., *National Boy Scout Councillor*



THE RIGHT WAY
Sketched by Doctor Crampton

Up at daybreak for a dip in the lake

A mess of bass for a healthy appetite

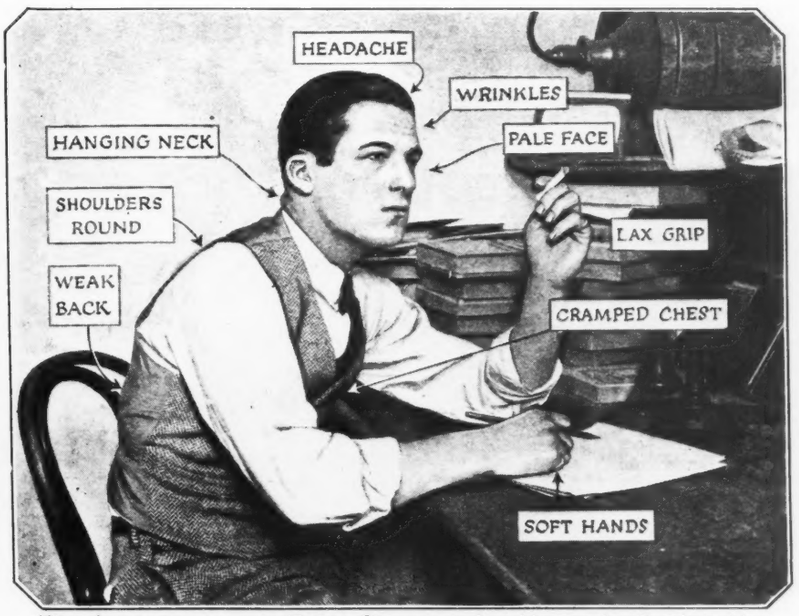
A sound sleep on balsam under the stars

Home again—a new man

EVERY man needs a vacation; some men need it more than others. The experience of thousands of young men has proved beyond question that the right kind of summer recreation can return a tremendous profit in health, happiness, and efficiency for the months of work that follow.

Yet the fact remains that a majority of vacations are wasted, usually through sheer thoughtlessness and lack of purpose.

It is the ambitious young man, eager for success, who asks: "How can I get the most value out of my vacation?" Hundreds of busy young men ask me that every year. And here's my answer:



The wise young man, says Doctor Crampton, plans his vacation first by taking stock of himself to find what parts of his body need repair

First, take stock of yourself. Go to a reliable physician for a complete overhauling. Find out just what parts of your body machinery are weakening under the daily grind. If your work is indoors, at an office desk, probably you have a weak back that needs repairing. As the result of careless posture your shoulders sag, your chest and abdomen are cramped, your neck droops. Your muscles are flabby, your face pale and wrinkled. You suffer from headaches and stomach disorders.

What you need is the vigorous kind of summer recreation that will expand your chest, allow your lungs to grow; tune up the mechanism of your stomach, intestines, liver, and other internal organs; harden your muscles and strengthen your heart.

If you are a wise young man, you will take time to study yourself. But in these days of jazz, you will be tempted to join the Vacation Boob. He is the vacationist who hops the first train for a breezy summer resort. He climbs off the train and into a bathing suit, gets chilled, lies on the beach to warm up and acquire a handsome coat of tan. Then, with an appetite like a horse, he hurries to dinner. He eats too much. Afterward he dances until midnight. Finally, at two a. m., he goes to bed, only to toss wakefully to the tune of sunburn.

On the beach again next day he is the object of solicitous feminine care while the blisters rise. The skin comes off his back and legs. He goes rowing, and the skin comes off his hands. He goes hiking in tennis shoes, and the skin comes off the bottom of his feet. Finally he returns to town literally skinned by his vacation. If he is no worse off than merely used up physically, he is lucky.

But if you are wise, you will follow the example of a young bank clerk I know. The first morning of vacation finds him getting off the train at Hickey Corners. By noon he has traveled 10 miles of corduroy road and has arrived at Lost Pine Lake. By night his camp site has been cleared, his tent is up, a roaring fire is burning under a substantial supper and a balsam couch is ready for the night's big sleep.

Next morning he is up before the sun to take a dip in the lake. Then fried bacon, twist bread, and coffee for breakfast. Afterward the morning's preliminary exploration of the country about the camp, followed by luncheon, a loafing afternoon, and a good mess of black bass for supper. Another night of luxurious balsam, and on the morrow a canoe trip around the lake.

That's his program for the next 12 days, and all the while he is breathing deeply of clean, fresh air; his lungs are expanding, his muscles are hardening, his heart settles down to strong steady work, and every part of his digestive machine begins to function smoothly. Each day is crammed full of solid enjoyment and health building. And he returns to his office with new vigor, enthusiasm, and energy. He has saturated himself with the power of all out-of-doors.

And that's the kind of vacation that pays.

THE WRONG WAY
Sketched by Doctor Crampton

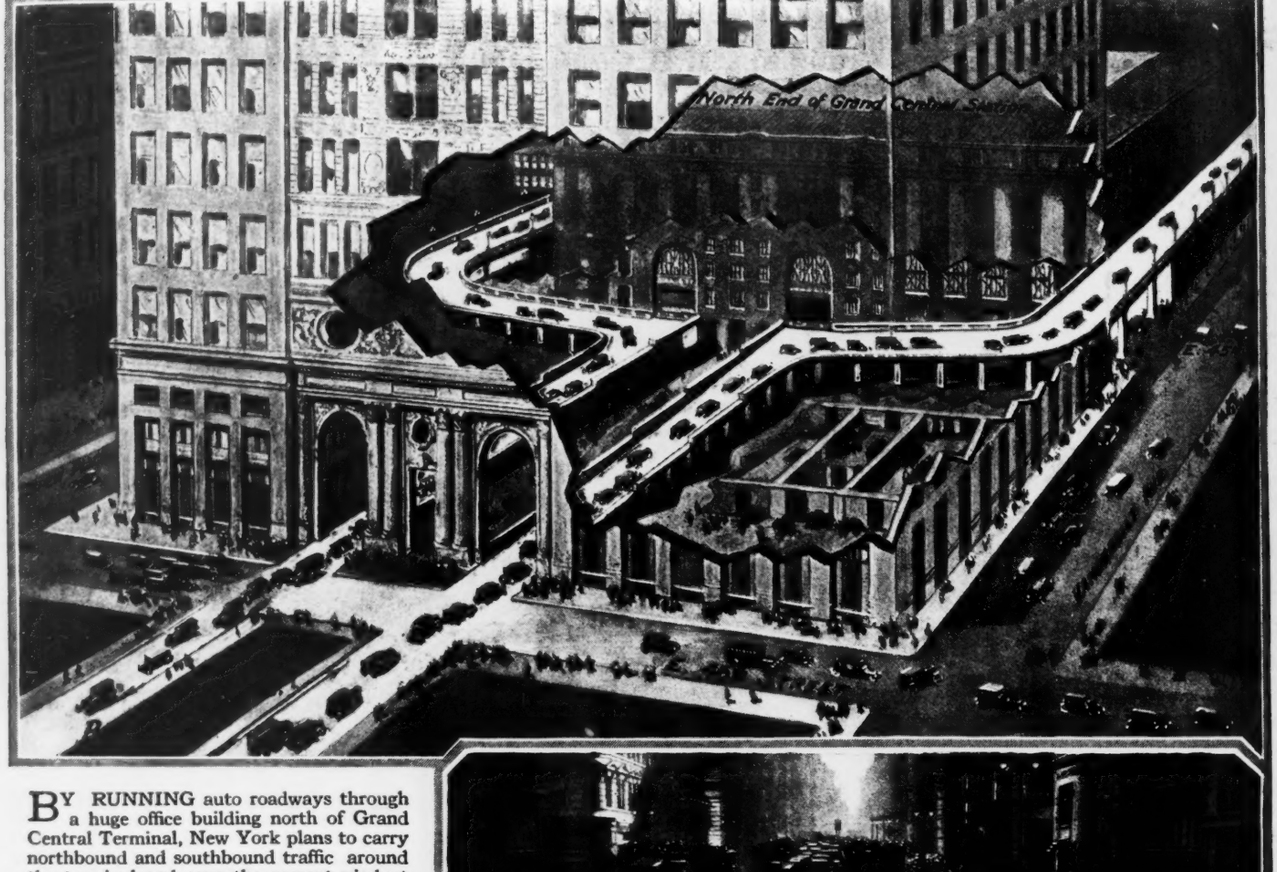
The first day—a bad coat of sunburn

A big appetite—he gorges himself at dinner

At the casino—he dances until after midnight

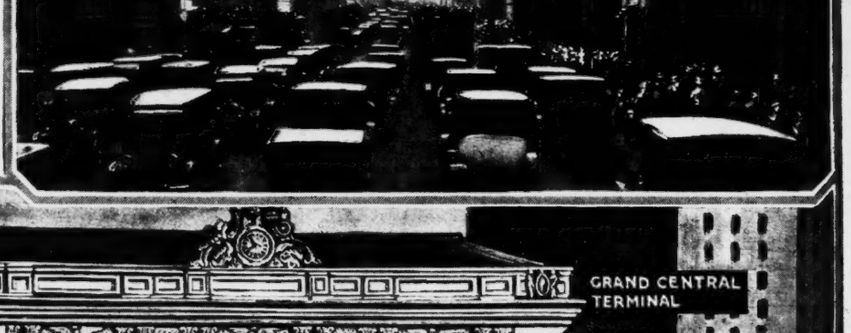
Home again—tuckered out

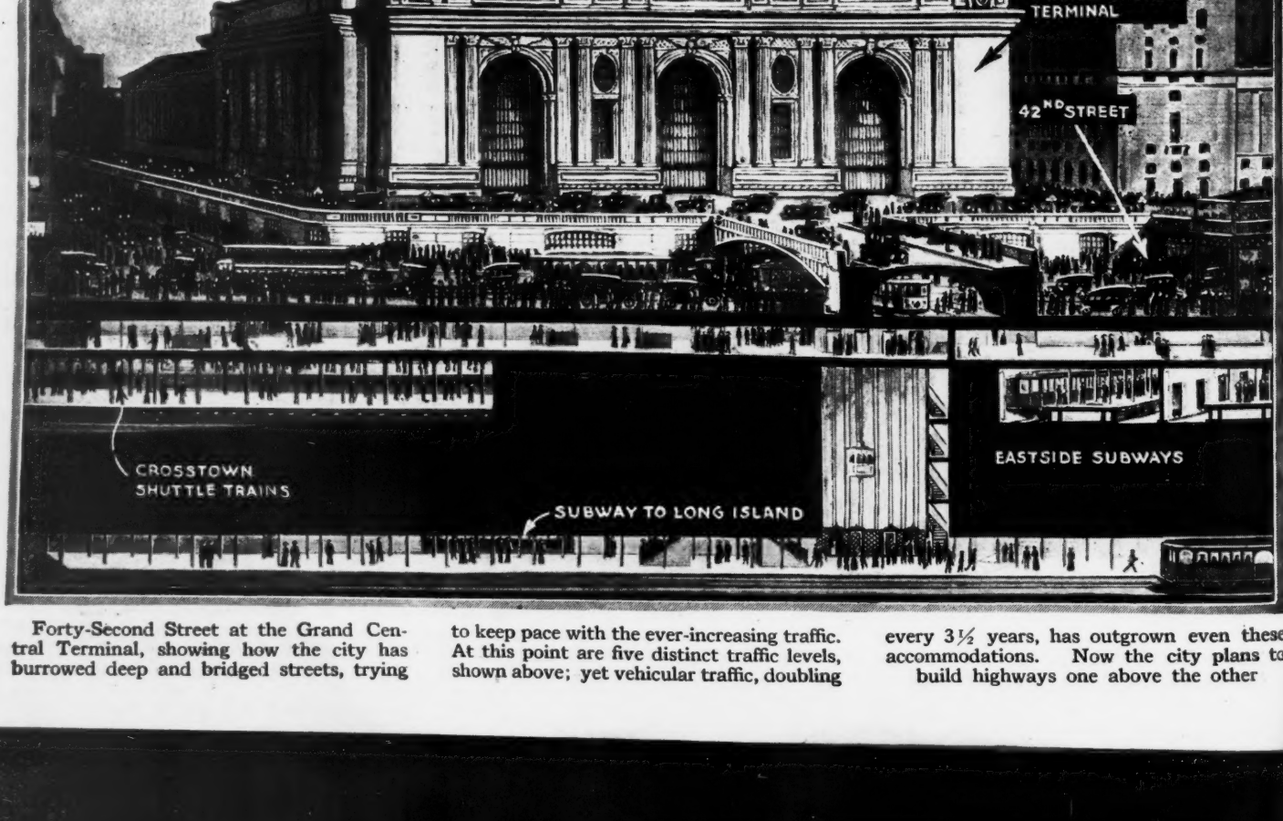
How New York Seeks Escape



BY RUNNING auto roadways through a huge office building north of Grand Central Terminal, New York plans to carry northbound and southbound traffic around the terminal and over the present viaduct above the congestion of Forty-Second Street.

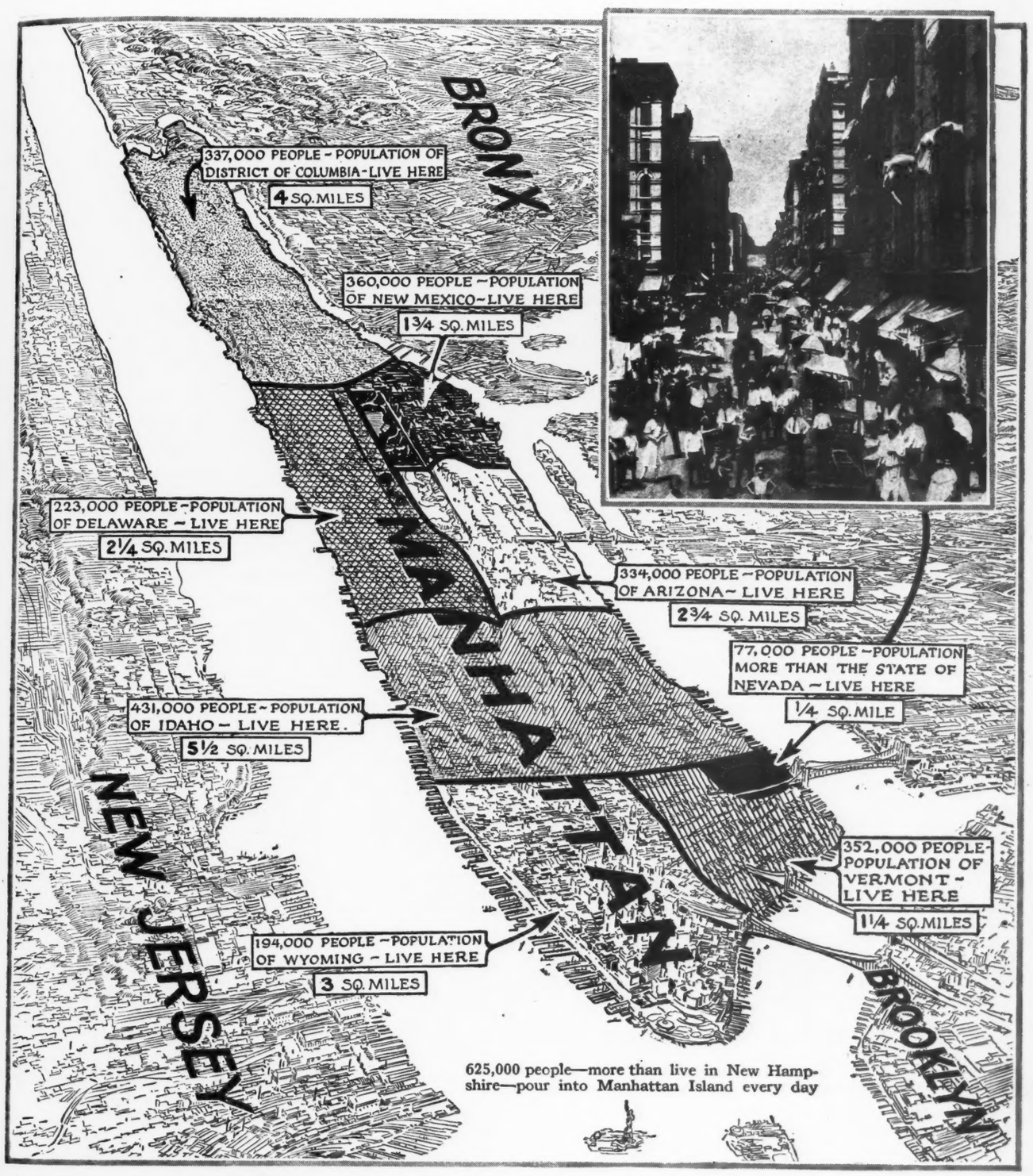
At the right is a typical jam along Fifth Avenue, a block away. Every 12 hours 20,000 vehicles from every state in the Union pass Forty-Second Street





Forty-Second Street at the Grand Central Terminal, showing how the city has burrowed deep and bridged streets, trying to keep pace with the ever-increasing traffic. At this point are five distinct traffic levels, shown above; yet vehicular traffic, doubling every 3½ years, has outgrown even these accommodations. Now the city plans to build highways one above the other

from Deadly Traffic Tangle


BRONX
337,000 PEOPLE - POPULATION OF DISTRICT OF COLUMBIA - LIVE HERE
4 SQ. MILES
360,000 PEOPLE - POPULATION OF NEW MEXICO - LIVE HERE
1¾ SQ. MILES
223,000 PEOPLE - POPULATION OF DELAWARE - LIVE HERE
2¼ SQ. MILES
MANHATTAN
334,000 PEOPLE - POPULATION OF ARIZONA - LIVE HERE
2¾ SQ. MILES
77,000 PEOPLE - POPULATION MORE THAN THE STATE OF NEVADA - LIVE HERE
¼ SQ. MILE
431,000 PEOPLE - POPULATION OF IDAHO - LIVE HERE.
5½ SQ. MILES
352,000 PEOPLE - POPULATION OF VERMONT - LIVE HERE
1¼ SQ. MILES
194,000 PEOPLE - POPULATION OF WYOMING - LIVE HERE
3 SQ. MILES
NEW JERSEY
BROOKLYN
625,000 people—more than live in New Hampshire—pour into Manhattan Island every day

CAUGHT in a snarl of traffic congestion unprecedented in the world, New York City is seeking escape from the smother of automobiles, railways, streetcars, and human beings that actually threatens the city's commercial life.

The bird's-eye map of Manhattan Island above shows how 2,300,000 residents—equalling the combined populations of seven states and the District of Columbia—are packed into an area of only 22 square miles. The inset photograph shows a typical view along one of the streets in the most thickly populated section of the East Side.

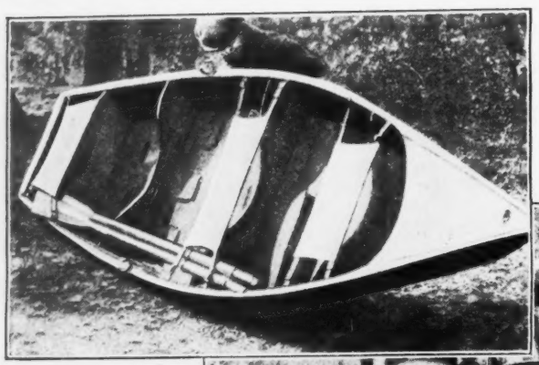
Yet this resident population of Manhattan, huge as it is, comprises only a comparatively small item in the growing traffic problem. From the New Jersey shore across the Hudson on the west; from the four boroughs—Brooklyn, Bronx, Queens and Richmond—which, with Manhattan, constitute Greater New York, hundreds of thousands of people and thousands of automobiles are dumped onto this one little island every day by ferries, railroads, bridges, and underriver tubes.

It has been estimated that 228,000,000 people—more than twice the population of the United States—are poured into Manhattan each year. And the flood continues to grow. Each of the four residential boroughs is far larger in area than Manhattan, and in each the population is increasing at a terrific rate. A few short years ago the Bronx was little more than 40 square miles of vacant lots; today it houses nearly 800,000 people. Brooklyn, with an area of 77 square miles, has more than doubled its population in the past 30 years, and now is equal to Manhattan. Queens, which is more than five times as large as Manhattan in area, promises a greater population within the next 20 years.

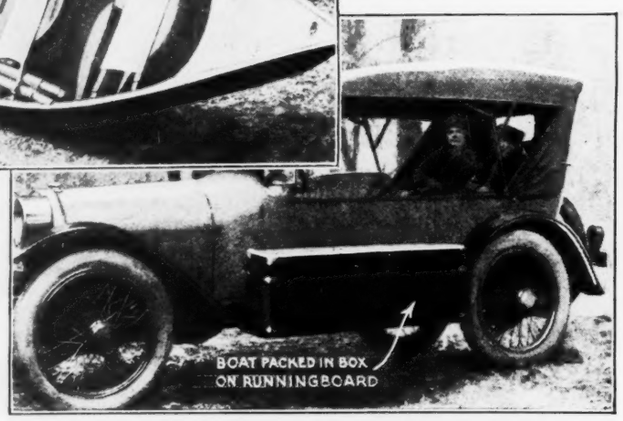
Thus, from all sides flow the swelling streams of traffic that pile into a jam on the little island of Manhattan. Every day 200,000 automobiles and 25,000 taxicabs ply its streets.

Attempting to keep pace with the deluge, New York City, having already honeycombed the earth beneath the streets, has resorted finally to the plan of building automobile highways one above the other. The first step in the plan is pictured on page 58.

Rowboat for Auto Tourists



At left: Collapsible rowboat ready for service. When knocked down, the boat can be packed in a small box on the running-board, shown below



A STURDY, yet collapsible steel and canvas rowboat that can be packed in a box 12 by 18 inches, recently has been perfected for the use of tourist fishermen.

Riding on the runningboard of a touring car, it can be taken along on a summer's week-end trip. It weighs less than 100 pounds and can be assembled in a few minutes.

The boat is built in 21 sections of three-ply laminated boards. They lock together by means of steel fasteners, no bolts or screws being necessary. No tools are needed. All the work can be done by hand.

When the sections have been assembled, a canvas cover is drawn over the frame and tautened by means of straps that also support the canvas seats. The boat is 12 feet over all when assembled.

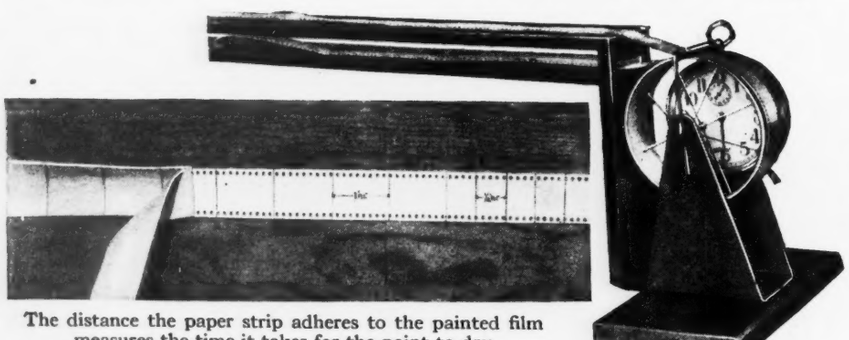
The stern is solid enough to support a small rowboat motor.

Lead and Alcohol Kill Auto Engine Knocks

LEAD is one of the heavyweights and alcohol one of the bantamweights of the chemical world, yet Thomas Midgeley, chemist of the General Motors, has made them join hands amicably to vanquish the "knock" in automobile engines.

The new compound is composed of six parts of ethyl combined with two parts of lead. By adding it to gasoline, a lower grade of that fuel may be used, it is claimed, without the engine knocking about it. Only a few drops are needed to produce the correct results.

Clock Machine Times Paint Drying



The distance the paper strip adheres to the painted film measures the time it takes for the paint to dry

HOW long does it take paint to dry? To answer this question accurately and to test the drying qualities of various paints and oils, Howard A. Gardner, of Washington, D. C., has invented a machine that automatically records the drying time to within a few minutes of absolute accuracy.

The machine consists of an alarm clock, which causes a drum to rotate with the hour hand. Upon this drum is wound a moving-picture film upon which the paint has been applied. Thin tissue paper is drawn into the machine with the painted film and pressed upon the painted surface.

While the paint is wet, the tissue paper is stained; but as soon as the paint dries, the paper ceases to adhere to the film. An inch on the film indicates an hour of drying. Thus if 24 inches of tissue paper sticks to the film, the particular paint being tested requires 24 hours to dry.

Tapioca from Poison Root

FEW people who enjoy tapioca pudding realize that they are eating a product of the poisonous cassava root. In its natural state this root is extremely bitter and harmful because of the hydrocyanic acid that it contains, but when heated it becomes palatable and its poisonous qualities are readily dissipated.

Golfer's Raincoat Rolls Up to Fit in Bag

RAIN need not bother the golfer who owns one of the new golf bag raincoats. The coat weighs only 15 ounces and can be rolled up and slipped into a golf bag.

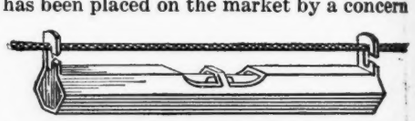
Its sleeves are short and loose to avoid interference with free action of the arms. Attached to the coat is a rubber hood that fits tightly over the head and keeps the rain from running down the golfer's neck.

The raincoat as worn by golfer

Inset shows coat rolled in bundle

New Level Hangs on Line

A NEW level for use in laying foundations, tile pipe, cement and brick walls and for other construction jobs, recently has been placed on the market by a concern



in Athol, Mass. Weighing only half an ounce, this level can be hooked over a line stretched between two points to determine the levelness of surfaces that are too rough for surface levels.

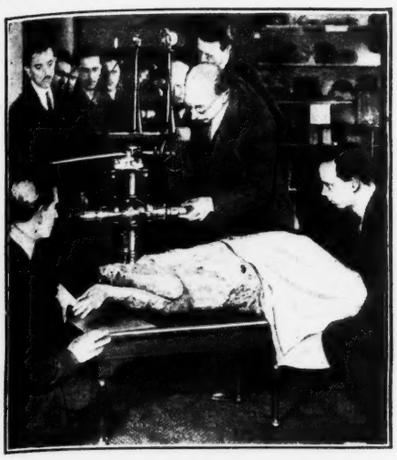
A luminous level glass with a yellowish fluid facilitates readings.

Arm-Mobile Newest Type of Kiddie Car

THE "arm-mobile" is a novelty in kiddie cars, recently invented by a resident of Oakland, California.

Two arms, each fastened off center to one of the rear wheels, are hinged together at the front end to a curved bar that swings on a pin under the front of the car. "Rowing" backward and forward turns the rear wheels and propels the car.

Propelling the car in rowboat style



Scientists X-Ray Mummy to Study Evolution

THE first X-ray pictures ever taken of a mummy were recently completed by scientists at the American Museum of Natural History, New York City. The pictures showing the skeleton in detail are expected to be a great aid in studying the development of bone formations in the evolution of man. The first subject of the scientists' X-ray was a South American Indian mummy.

Water in Paper Bag Can Be Heated over Flame

IN SMALL town hotels where hot water is not available for shaving, traveling men sometimes fill a paper bag with water

© K. & H.

Boiling water in a paper bag

and hold it over a lighted gas jet. They know that the heat from the flame, traveling upward, will heat the water and will keep the bag dry without burning it.

A New Chemical Element

TWO Danish scientists, Dr. G. Hevesy and Dr. D. Coster, working at the city of Copenhaven, have announced the discovery of a new chemical element which they call "hafnium."

Hafnium was discovered by means of its X-ray spectrum. It occupies, the Danish scientists believe, one of the six vacant places long known to exist in the list of the chemical elements.

Strange to say, this latest recruit among the chemical elements seems to be quite common in the world. Doctors Hevesy and Coster think there is more of it in the earth's crust than there is of gold.

Cypress Vaccinates Itself

AGES before Dr. Edward Jenner discovered how to make us immune from smallpox by vaccination, the long-living and prolific cypress tree used practically the same method to procure immunity from rot. This astonishing fact was discovered recently through scientific study of the most famous trees in history.

Cypress trees are numbered among the oldest living things on earth. The age of one tree in Louisiana is estimated at 2500 years—its life was just beginning when Nebuchadnezzar captured Jerusalem.

A group of giant cypress trees, showing strange anchoring roots. Inset shows typical "pock marks" in cypress

This long life is largely due, scientists say, to the fact that the trees manufacture their own preservatives. The majority of cypresses suffer from a sort of vegetable smallpox. "Pock marks" similar to those that appear on human smallpox victims, develop as blemishes in their wood.

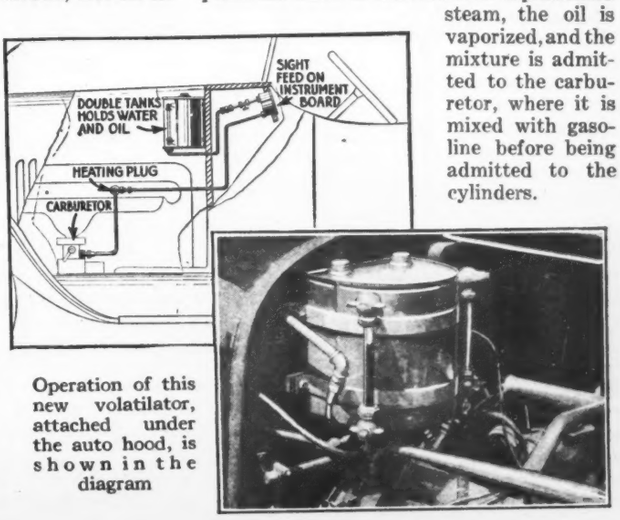
The disease is caused by a fungus that penetrates the tree through broken branches, dead tops, or decaying knots. These holes fill with a brown powder.

Strange to say, this powder acts as an antiseptic that finally kills its parent fungus and ends the disease. Further, the powder is absorbed by the sap of the tree and acts as a general preservative, immunizing it from rot.

New Gasoline Vaporizer Uses Steam

ON THE principle that superheated steam breaks down carbon, Dr. K. A. Mayers, of San Antonio, Texas, has invented a volatilator for gasoline engines which, he claims, increases the engine's power, prevents carbon deposits, and provides a lubricant to the moving pistons.

The device consists of a copper tank fastened to the dashboard, a sight feed, a heating plug, and pipe line system. The tank contains oil and distilled water, which flows through a sight feed in front of the driver. From here the oil and water mixture is conducted to a heating plug on the exhaust manifold. At this point the water is converted to superheated steam, the oil is vaporized, and the mixture is admitted to the carburetor, where it is mixed with gasoline before being admitted to the cylinders.



Operation of this new volatilator, attached under the auto hood, is shown in the diagram

World's Largest Photograph

Here is a portion of the world's largest photograph, 96 feet long and 10 feet high, in the Academy of Sciences, Chicago. It forms the background of a display showing a panorama of the Lake Michigan shore near Gary, Ind., and the famous Indiana sand dunes

New Safety Locknut Held by Pronged Pin

A RECENT innovation in safety locknuts marks an improvement over existing types in that it can be applied to an ordinary bolt without a cotterpin hole.

In the upper surface of the nut is a depression into which fits a two-pronged forked pin. The inner sides of the two pin points are sharpened to fit into the bolt threads.

When the nut is screwed down as far as it will go, the pin is driven into the slot and the points are then bent around the bolt. In this way the nut and bolt threads are pressed tightly together, holding the nut firmly. To remove the nut, the operation is reversed. A hole in the butt end of the pin provides a means of pulling it out.

A Homemade Seed Tester

FROM an ordinary dinner plate and two pieces of blotting paper any backyard gardener can make a simple and effective seed tester at home.

Cut the papers so that they fit the plate, one on top of the other. Then pour on enough water to wet both papers thoroughly. Now place from 10 to 50 seeds between the sheets of paper. Keep the plate in ordinary room temperature and the papers moist. If the seeds do not sprout, they are sterile and you should obtain a new supply.

New Belts to Straighten Postman's Shoulders

ALMOST any morning now you may meet the mail carrier dressed up in a modified Sam Brown belt. And instead of hunching up his left shoulder that bears the sack, he will be walking upright.

The right shoulder of almost every mail carrier is about an inch lower than the left, due to the weight of the mail sack, carried on the left side.

It is to correct this tendency that the Post Office Department is experimenting with two belts. One has a strap around the waist with hooks to support the bag. The other has a strap over the right shoulder, to distribute the load.

Life of Building Is from 25 to 100 Years

HOW long will a building last? For the guidance of property owners who are not sure how much to charge for depreciation in figuring taxes, the Federal Internal Revenue Bureau gives the following:

"The average usual life of a frame building is 25 years, a brick building 35 years, and a stone or concrete building from 50 to 100 years."

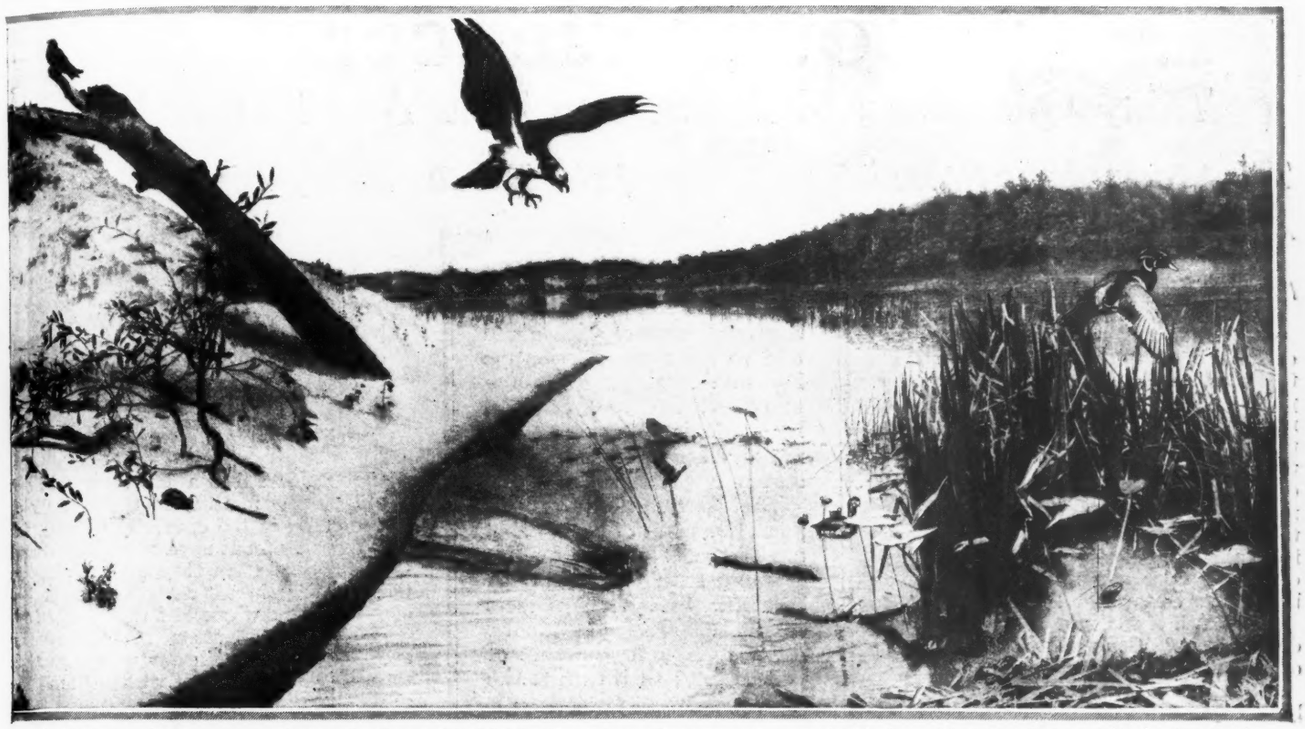
Flashlight Tool Handle for Auto Repairs

TO FACILITATE working with tools in the dark, a useful flashlight handle that will hold a wide variety of tools has been designed especially for automobile owners. The flashlight is so placed that it throws its beams directly upon the work.

The handle screws into the sockets attached to each tool.

The flashlight handle and variety of tools that can be attached

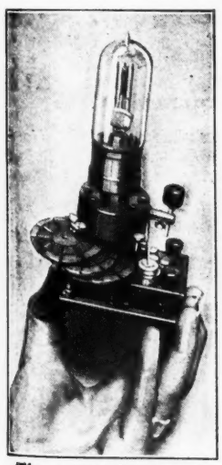
Nearly as Long as a City Lot



This huge picture was made by Dr. Frank M. Woodruff, curator of the Academy, who declares that the photographic background is more accurate and scientific for purposes of display than the oil painting method, while it costs less than one tenth as much

New Vest Pocket Radio Set Has 100-Mile Range

NEARLY every radio fan has seen many of the commercial and homemade "smallest" sets that have appeared from time to time, often taking the form of the crystal set that fits into a pocketbook. Most of these sets, however, have been of the freak variety, with a receiving range usually limited to about five or 10 miles at most. They serve as an introduction to the fascinations of radio, leading the fan to larger sets.



The compact vacuum tube radio set

A new set of the vest pocket variety, embodying the essential features of long range sets, uses a combination of crystal and vacuum tube detector. It can be operated with or without batteries and has an effective range of from 50 to 100 miles.

In spite of its small size, the popular and efficient three-circuit hook-up is used, with spider-web coils for the primary, secondary, and tickler inductances. Rough tuning of the primary circuit is accomplished by a three-point switch, while the finer tuning of the set is accomplished by varying the inductive relationship of the three coils.

These intricate features are embodied in a remarkably compact instrument, little larger than a man's hand.

Power Lawnmower Made from Cultivator Frame

A CULTIVATOR frame with gasoline engine has been converted into a power lawnmower by an Ohio concern.

A 30-inch lawnmower is attached to the frame of the cultivator by means of special fastenings. When the small gasoline engine is running and the clutch is thrown in, the mower is guided with little exertion on the part of the operator.

When an obstruction is encountered, such as a walk, the operator depresses the handles. This raises the cutting blades while the cultivator continues to move forward. When the obstruction has been passed, the blades are lowered again by raising the handles.

The ingenious machine is especially adapted for use on golf courses.

Lifelike Toupées Now Are Spun from Glass

HAIR spun from glass is now being used by German wigmakers in manufacturing lifelike toupées. They claim that glass hair is the most effective substitute for real hair yet devised, defying detection.

The glass wigs are said to be light in weight. Curls and waves can be produced, and the color won't run.

Telescope and Binoculars in One Instrument

A FIELD glass provided with an auxiliary lens for astronomical observations has been perfected recently for use in near and far vision.

The auxiliary lens is contained in a cylindrical tube attached to the front of the binoculars. This closes off one of the eyepieces and directs all rays to the other eye. In this way the glass is used in observing the stars.

The binoculars with telescope attached

How Much Do You Know about Science?

Thirty Questions and Answers to Test Your Knowledge

The Story of the Stars—The Story of the Earth—Every-Day Chemistry

Answers to the questions asked in this article are published on page 101

THE questions this month begin with the Story of the Stars.

Did you know that the sun was the only star in our solar system? The "stars" that most people know best are really the planets—Venus, Mars, Jupiter, and the rest. They are so far off that it takes thousands of years for light from them to reach us, and light travels at the rate of nearly 200,000 miles a second. Yet modern astronomers, with their long range telescopes, have been able to reach out into space and tell what the stars are made of. With their spectroscopes they have been able even to weigh the stars.

How much of what they have found out do you know? Can you read the heavens or is it all still a mystery to you?

These questions will help you test your knowledge.

The Story of the Stars

1. How large is the universe?
2. Why do the stars twinkle?
3. Are the stars solid?
4. Why do stars appear to be pointed?
5. Can the future be told by stars?
6. What causes an eclipse of the sun?
7. Why does the sun shine?
8. Why does the moon shine?
9. What is the moon made of?
10. What would happen if the earth collided with a star?

The Story of the Earth

FOUR or five billion years ago the earth was formed. Since then a great many things have happened to the earth and science has been able to read the record of most of these happenings, at least from the first appearance of life in the fossils left in rocks.

TO HELP every reader test his knowledge of the fundamental facts of science and add to his store of scientific information about every-day things, POPULAR SCIENCE MONTHLY is publishing every month a series of simple, yet searching questions.

The 30 questions on this page, like those of last month, are selected from the queries of more than 6000 POPULAR SCIENCE MONTHLY readers and by 20,000 school students. Answer them to the best of your ability; then turn to the correct answers on page 101. Grade yourself 10 points for each question answered correctly, and see how near you come to a 100 per cent score for each classification.

The six or eight thousand years of known human history are no more than a moment in the history of the world. Science had to go far beyond the earliest human history to find the reasons for such commonplace things as the soil of our fields, the water in our lakes and rivers, the sand on the beach, the vegetation that covers the earth, the animals we use and eat and, most important of all, the origin of man. See how much of this knowledge you have acquired.

1. How do we know the earth is round?
2. Is the inside of the earth molten?
3. Why are stones in streams round?
4. Is man related to the monkey?
5. What is the greatest known sea depth?
6. What is air composed of?
7. What causes the wind?
8. What causes rain?
9. What causes snow?
10. Why is frost more likely on a clear night than on a cloudy one?

Every-Day Chemistry

CHEMISTRY has a lot to say about every-day matters in the household, in the office, in the open. It tells us, for instance, why foods have to be cooked and what happens when they are cooked. It tells us why bread rises; why milk becomes sour and why cream rises to the top.

Every day scientists are discovering amazing facts about common things that we are inclined to accept without inquiring about them.

Your silver becomes tarnished and you spend hours rubbing and polishing it without, perhaps, knowing what made it tarnish. Chemistry will tell you. Chemistry also will give you the reasons for thousands of things that happen every day.

How much do you know about this fascinating subject? These 10 questions will test your knowledge.

1. What is fire?
2. What makes automobiles smoke?
3. Why does iron rust?
4. What test distinguishes wool from cotton?
5. Why does milk turn sour?
6. Why does yeast make bread rise?
7. Why does bluing bleach clothes?
8. Do thunderstorms turn milk sour?
9. Why is salt lumpy in wet weather?
10. Why does silver turn black?

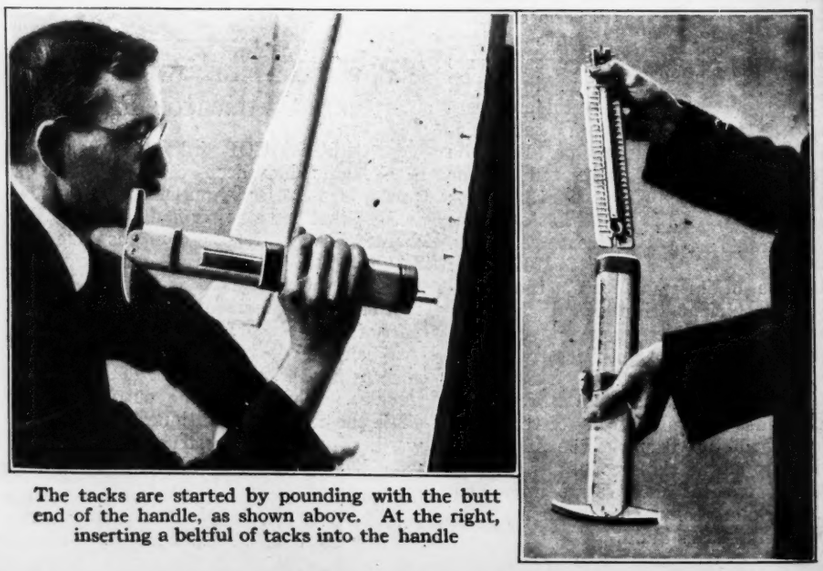
Next month—Electricity and Radio—What Is Life?—The Story of the Mind

Self-Feeding Hammer Drives Four Tacks a Second

WITH a self-feeding tack hammer recently invented, one can tack placards and decorations without paying the usual price of bruised fingers. Tacks are contained in the handle of the hammer and need not be handled by the person driving them.

An endless fabric belt to which 70 tacks are glued, runs inside of the handle from the butt of the hammer to the head. The tacks are automatically fed, one by one, into a device, which projects them, one at a time, point outward, at the butt end of the handle. When the supply of tacks is exhausted, the old belt can be replaced by a new one, as shown in the illustration at the extreme right.

The operator, striking with the handle butt on the spot where he wishes to drive a tack, starts the tack in the wood and loosens it from the belt. The tack is then driven in the usual manner. It is said that more than four tacks a second may be driven with this hammer.

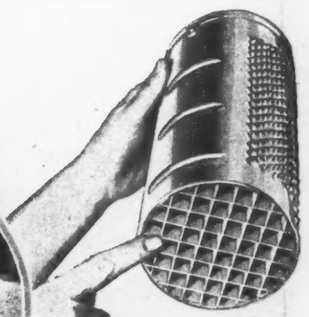


The tacks are started by pounding with the butt end of the handle, as shown above. At the right, inserting a beltful of tacks into the handle

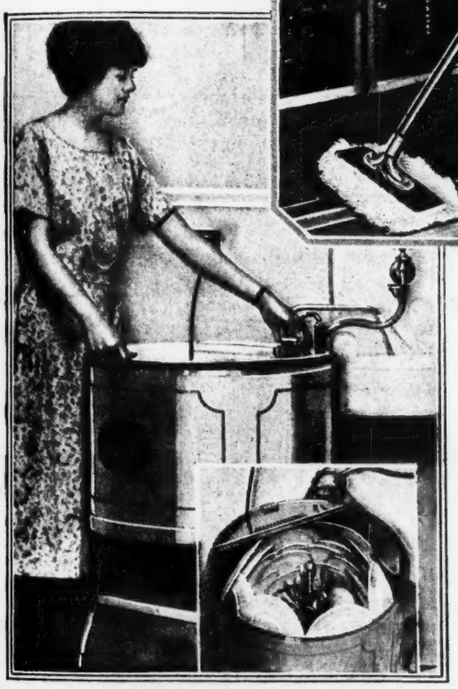
New Inventions for Woman's Workshop

Shaped like a saucepan, this asbestos lined frying pan is said to save 25 per cent of gas ordinarily required. Also the odors of the cooking food are confined to the pan. The bowl shaped center can be removed for cleaning

The feature of the new vacuum floor mop shown above is that while it polishes, it sucks all the gathered dust from the mop and thus does away with the unsanitary custom of shaking the mop outdoors



Three different utensils are combined in the kitchen implement shown above. There is a vegetable dicer, a slicer for cutting potatoes or hard boiled eggs, and a grater



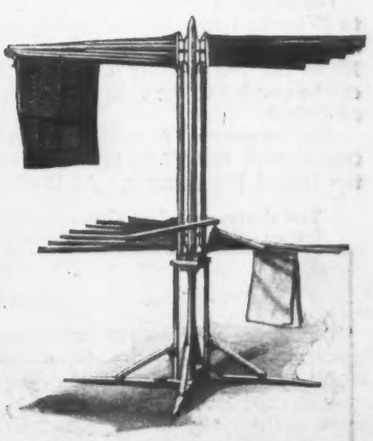
The motor that drives this new portable electric dishwasher sprays the dishes with water drawn through a flexible tube from the faucet; then pumps out the used water through an exhaust pipe into the sink

A memory aid that will save steps and telephone charges

Attach a brush, with flexible rotary drive, to the motor of the vacuum cleaner and stove polishing becomes a pleasure instead of drudgery

Three chairs in one make a welcome fixture for restricted floor space

Safe window cleaning is provided by this new double hung sliding sash, both halves of which are divided to open inward



Weighing only 15 pounds, this rack gives 63 feet of drying space when opened

Narrow Gage Railways *vs.* Trucks

Courtesy *Engineering News-Record*

Operating on a feeder line of the Buenos Aires Southern Railway, this narrow gage train is cutting transportation costs

FARMER-OWNED narrow gage railways, to replace motor trucks and teams as feeders to standard gage main line roads, were proposed as a measure of economy at a recent forum on transportation and agriculture at Ithaca, N. Y.

Narrow gage roads are now being used successfully for this purpose in the Argentine, South America, where four lines, totaling 150 miles in length, are in operation. The result is said to have been a marked reduction in cartage charges, and consequently in food costs.

At the Ithaca conference Edward Hungerford, of Rochester, N. Y., an expert on transportation, pointed out that while the motor truck is an efficient short-haul carrier, it is wasteful on long hauls. A crew of nine men on a railroad train, he declared, can handle from 300 to 500 tons of freight a day, while to handle the same amount by motor truck would require from 300 to 500 trucks and chauffeurs.

The "feeder" roads in Argentina have a 24-inch gage. Steam and gasoline engines are used. A 45-horsepower steam locomotive weighing 12 tons can haul 17 cars of 7-ton capacity through hilly country. The 40-horsepower gas engines can haul 12 cars.

The old and the new transportation systems in Argentina. Note the high wheels on the horse drawn wagons in the background of the picture

Uncle Sam's Speediest Fighting Ship, "Omaha"

TWO distinct power systems—one for ordinary cruising speeds, the other for tearing through the seas at the speed of an express train—drive the most powerful ship in Uncle Sam's navy, the new scout cruiser "Omaha."

The high speed system consists of four Westinghouse turbines capable of developing 90,000 horsepower, driving the "Omaha" at a speed of 35 knots, or 42 miles, an hour. Never before on land or sea has such tremendous power been installed in so small a space. The turbines of the "Majestic," largest steamship in the world, develop 100,000 horsepower, but the "Majestic" is nine times larger than the "Omaha."

For High or Low Speeds

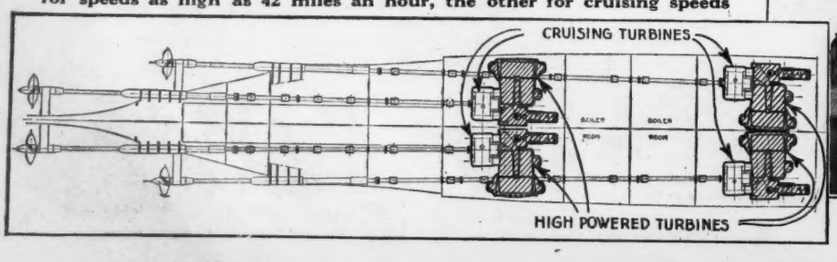
For ordinary cruising speeds of from 12 to 15 knots, four small turbines developing a few thousand horsepower are provided. Either the high speed or low speed systems can be coupled to the twin propeller shafts, as desired.

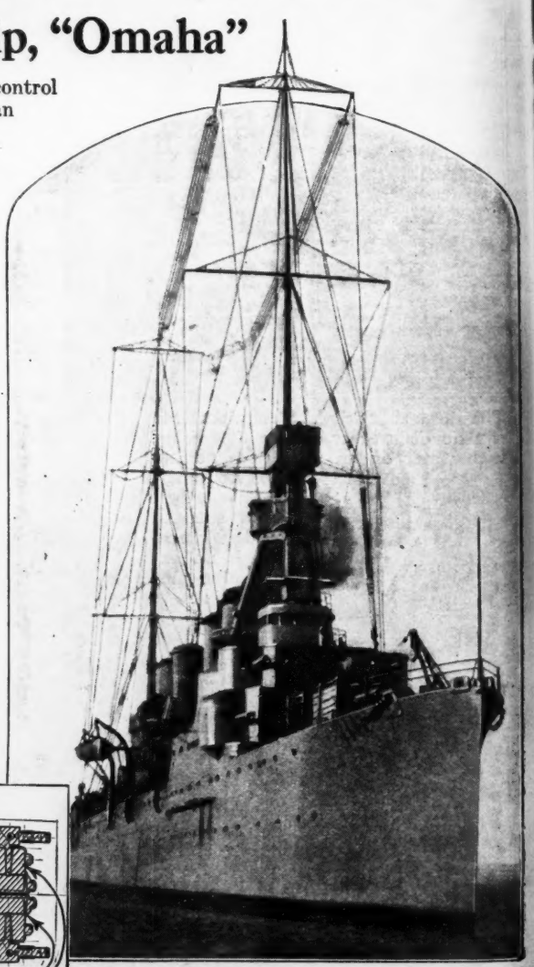
Another unusual feature of design is the tripod mast, first of its kind ever used in the United States navy. At the head of the tripod is an inclosed fire control station from which the battery can be directed.

The "Omaha" has a displacement of 7500 tons. Her beam is 55 feet and her length 556 feet, giving a ratio of beam to length of one to 10. She has a battery of 12 six-inch guns, a secondary battery of two three-inch 50-caliber aircraft guns, two three-pounder saluting guns, and two 21-inch twin torpedo tubes.

The "Omaha" is the first of 10 cruisers of her type now being built for the navy. These vessels will fill a gap in the navy that long has worried naval officers. At the present time Japan and Great Britain are better equipped with cruisers and other auxiliary types of vessels than is the United States. The 5-5-3 naval ratio applies only to capital ships, and there are no restrictions on auxiliary vessels.

The diagram below shows installation of interchangeable turbines, one for speeds as high as 42 miles an hour, the other for cruising speeds

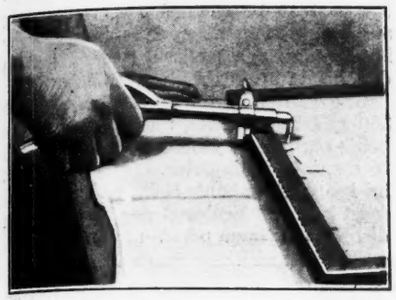




U. S. S. "Omaha," newest and most powerful ship in Uncle Sam's navy

Small Grip Tool Drives Nails by Pressure

A POWERFUL little tool for driving nails and tacks in inaccessible places has been designed especially for upholsterers and picture-framers. The tool drives



nails by means of forceps that are brought together by pressure on grips at the handle. It eliminates the danger of breaking glass or marring fine furniture with a hammer.

Cardboard as Disk Cutter

A DISK cut from a strong piece of cardboard and attached by a string to the wheel of a sewing machine can be made to serve as a perfect rotary disk cutter.

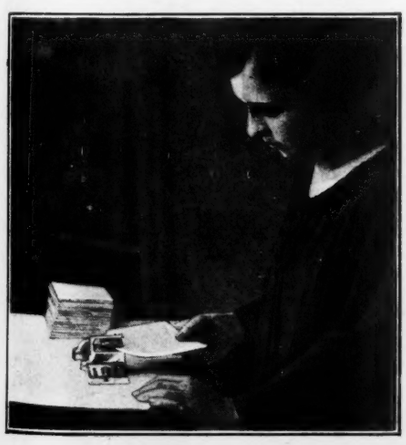
By giving the disk a high speed, it is possible even to cut a pencil in pieces.

Simple New Envelope Sealer Is Clamped to Desk

AN INEXPENSIVE envelope sealer that can be clamped to any desk or table is one of the newest office accessories on the market. The machine is made entirely of metal and has only one moving part.

The envelope is sealed by first passing the flap between a moistening roller and a spring made of strips of nickeled silver, then pulling it through another set of springs, which seal it securely.

The roller is made of aluminum. It is easy to clean and always sanitary. All



How the machine seals envelopes

sizes and shapes of envelopes can be sealed with the device. It also will moisten gummed tags, labels, and stickers.

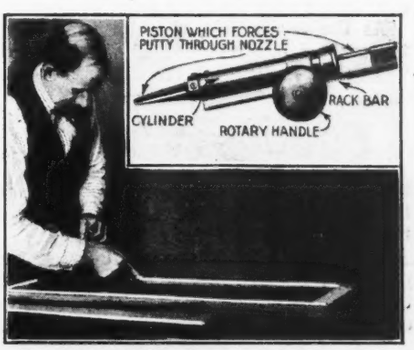
City Directory Works Automatically

TO ASSIST strangers in locating municipal buildings, railroad stations, or business houses, an automatic city directory recently has been installed in Miami, Fla. The apparatus consists of a large map of the city and a printed list of buildings and stores. When the inquirer presses a button alongside the name of the firm or building he wishes to locate, a red light flashes the location on the map. A green light shows the present location of the person who presses the button. A white light shows where the streetcar is to be taken in order to reach that destination and a blue light indicates a point of transfer.

Lights point the way when a button is pressed

The various places are listed under separate headings, such as Hotels, Depots, Subways, and Stores, so that, by looking under its correct class heading, any place can readily be located.

Piston Tool Applies Putty Quickly



Puttying window frame with new tool

A HANDY tool for evenly and quickly applying putty has been invented by Charles H. Weber, of Columbus, Ohio. It consists of a cylinder and piston, the outer end of the piston being attached to a rack bar that is in mesh with a pinion attached to a rotary handle.

The piston forces the putty through a tapering nozzle. The top plate of this nozzle is bent at the outer end to provide a small tamping member for pressing down the putty.

The new invention is designed to feed the putty in exactly the right quantities, and to eliminate the usual soiling of the workman's hands when applying putty with a knife.

Molding Book Ends and Toys of Wax

ORDINARY wax or sealing-wax now may be utilized by any woman in decorating the home or in entertaining the children, through the perfection of a new molding process by a Chicago inventor.

Molds for paperweights, book ends, and various animal toys have been put on the market with complete directions as to their use.

In making children's toys, the molds are first cooled with water. Melted wax is poured in both sides of the mold. The sides are then held together by rubber bands until the wax sets. After being placed in an icebox to cool for a few moments, the molds can be lifted off, leaving a complete wax statuette. A complete zoo can be made in this manner.

The process is so simple that a child can make his own animals. The child should be cautioned, however, not to burn itself. The wax can be used many times and there is no end to the game's fascination.

For making book ends and paperweights the same process is used, except that sealing-wax is substituted for ordinary wax and the molds are larger. Lead bases are furnished to give the required weight. A little more care in finishing is needed in making these.

Typical animals and book ends molded from wax melted as shown above

Auto Charts Road Surfaces

INSTEAD of inspecting a road surface to see where it needs repairs, the up-to-date highway engineer now can drive over the road in a car equipped with an ingenious new instrument that automatically charts the road surface.

The machine, of aluminum, is mounted on the dashboard. Connected with one of the front wheels of the car is a shaft that drives a strip of paper six inches wide through the recording instrument. Two recording pencils are actuated through connection with the front axle.

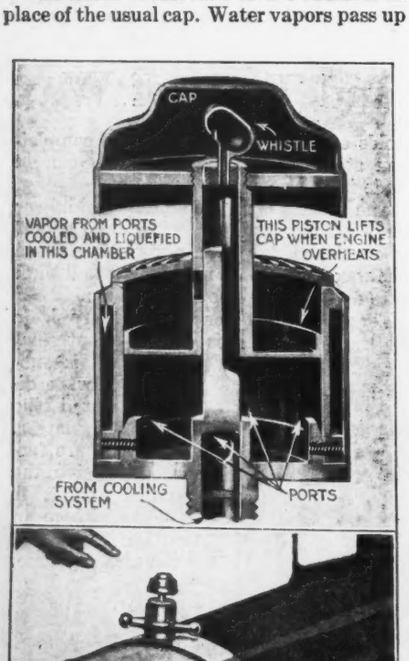
As the car travels, the chart moves at the rate of one inch for 50 feet of road, while the pencils mark the chart.

Overheated Radiator Sounds Warning

AN UNUSUAL alarm recently perfected serves the double purpose of condensing the vapors generated in the radiator and of signaling by whistling and exposing a red disk whenever the water becomes too hot.

The alarm is fastened to the radiator in place of the usual cap. Water vapors pass up through a central port into a chamber, where they are liquefied by coming in contact with the cool outer walls of the chamber.

If the heat rises above 190 degrees, the pressure increases, raising a piston fastened to the top cap, and exposing the red surface of the chamber. This signifies something wrong. A further increase in pressure will raise the piston still higher, permitting the gases to enter a port on the hollow piston and to pass through a whistle in the cap that signals great danger. Should the water continue to heat up, the cap will be raised and the steam will escape.



The signal cap and its mechanism

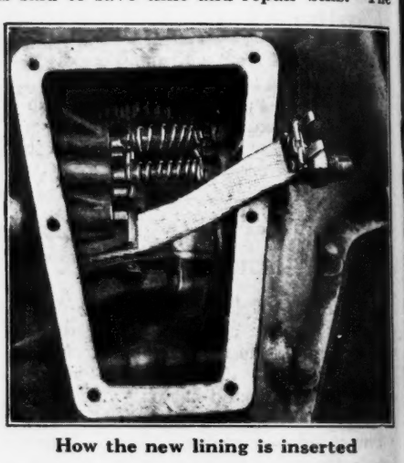
Auto Engines Cleaned by Air Pressure

DEPOSITS of oil and dirt can be readily cleaned from automobile engines and frames by air pressure. The apparatus consists of a long nozzle through which a mixture of air, oil, and water is sprayed on the part to be cleaned at a pressure of about 90 pounds a square inch. The spray is directed against the surface from a distance of approximately 18 inches.

One gallon of oil is used with about 300 gallons of water, the correct mixture being produced by mixing valves attached to a special oil injector. The water must be heated to about 100° F., and the oil must be a light-colored gas or petroleum distillate having a paraffin base.

New Transmission Linings Save Repair Bills

FORD owners will be interested in a new quick change transmission lining, which is said to save time and repair bills. The lining can be installed easily without changing the construction of the car.



How the new lining is inserted

In changing the lining, it is necessary only to remove the plate on the transmission cover, slip out the worn linings and slip in the new ones. The three linings can be changed in half an hour by one man.

Safety Fender Safeguards Lives

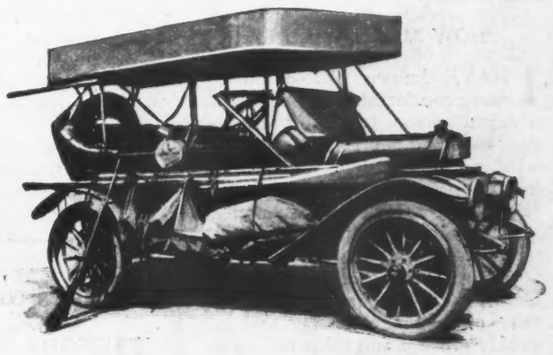
A NEW automatic safety fender that drops instantly to the pavement if a car strikes a person, recently has been approved by the Underwriters' Laboratory as a valuable accident prevention that will save many lives.

The fender consists of a bumper, a horizontal trip bar, and an automatic screen. The trip bar is placed an inch or two in front of the fender and extends from one front wheel to the other. The instant a person is struck, it releases the fender, which drops to the ground and prevents the person from being crushed. Meanwhile the driver has his hands free to stop the vehicle as quickly as possible.

A blow on the trip bar automatically drops the fender

Gypsying de Luxe by Auto

Whole Nation Is a Playground for Summer Tourists; How to Make the Auto Trip Successful



Loaded to the springs. Here's the way auto-camping used to be done. Nowadays everything—from bed to boat—folds into neat little bundles that fit in a box. Yet this oldtimer has seen lots of fun. It has traveled 200,000 miles and is still good for more. The queer top, when removed, serves as a boat

By Harold F. Blanchard

AT LEAST a million people are going auto-camping this summer.

Only a few years ago the fascinating summer sport of "camping out" was limited to a very few vacationists who were willing to "rough it"—to put up with its inconveniences and even its hardships. Today the automobile, with its constantly increasing number of new accessories providing home comforts, has brought the joy of the open road and the wooded places within reach of every one.

Auto-camping has become the national summer pastime. Last year more than 1200 public camp grounds were in use. This year the number is well over 2000.

For the auto-camper, the whole United States is available as a summer resort. There is hardly a town in the country where he cannot camp. No longer is the vacationist tied to one spot along the shore, lakeside, or in the mountains. Such things as reservations, high prices, and neighbors mean little to him. He rambles where he will and halts according to his whim. In his car he has found the nearest approach to absolute freedom and contentment during his vacation days.

And not only has automobile camping proved to be a delightful way to spend a vacation, but an economical way as well. Compared with other forms of outing, the initial expense and the running expense are small. A modest camping outfit may be assembled for less than $100. There is a satisfactory, practical, durable outfit to fit every pocketbook.

I am assuming, of course, that the prospective auto-camper already owns a car. If not, there are plenty of small but serviceable used cars to be had for $200. And right here I suggest to the man who has no need for a car through the winter months that he buy a used car for his camping trip and sell it when he gets home. If he pays $200 for a secondhand automobile, he should be able to dispose of it for $150 or $175.

PREPARING CAR

FIRST of all, to avoid mechanical trouble on the trip, the car should be carefully inspected and repaired. Be sure that the carbon is removed, the valves are ground, the breaker points properly adjusted, the lubrication system is clean, the clutch in adjustment, and transmission and rear axle in good condition and lubricated. Wheels, universals, and steering gear should be lubricated, brakes adjusted, and a spare fanbelt taken aboard. Tires should be examined and spares purchased if necessary. Finally, all nuts should be tightened, including those holding the electric wires.

Provided the engine bearings are in adjustment, the engine is not likely to break down unless the lubrication fails. The clutch should not give any trouble if it is in good working order at the start. Transmission and rear axle are hidden parts, and if their inspection covers have not been removed for some time, it is a good plan to remove them just to make sure there are no parts so nearly worn out that they are likely to break at some critical moment of the tour.

In Nature's beauty parlor the morning wash is a real joy, especially when the front door of the old flivver serves as a hinged dressing box to hold the complete clean-up outfit, which includes mirror, washbowl, soapbox, two brushes, and a place for towels

It Pays To Be Prepared

It is inexcusable folly to have something go wrong 50 miles from nowhere, and then wish vainly that you had purchased some badly needed gadget before you started. A collapsible bucket, for example, is almost indispensable if the engine overheats and the water boils away. An extra gallon or so of oil and five gallons of gasoline are other factors of safety.

The car certainly should have a set of chains. Mudhooks, too, will be found useful, for with them it is possible to walk the car out of almost any mud hole. A tow-rope is another useful piece of equipment, and there have been times, too, when a block and tackle have come in handy. At least one pocket flash-lamp is essential, plus some extra batteries and bulbs. If possible, every member of the party should have a flash-lamp.

The car should receive systematic care during the trip. Every morning, without exception, a certain routine should be followed. Gasoline tank, oil reservoir, and radiator should be inspected to see that they are full. It does not pay to guess that you have enough gasoline or oil or water. The tires, including the spares, should be examined. Any tires requiring inflation should be attended to at the first garage.

All grease cups should be given a turn or two, and any empty ones should be filled. All oil holes on the chassis should be given a few drops each. If the camping trip is an extended one, remember that universals should be refilled every 3000 miles, and that it is also good policy to lubricate the transmission and rear axle, steering gear, and wheels at this time. The valves on most cars will re-

quire grinding every 3000 to 5000 miles.

I am convinced that best results are obtained by changing the engine oil every 500 miles. It means more power and better engine wear.

HOW MUCH WILL IT COST?

I HAVE known auto-campers to get along comfortably on as little as a dollar a day a person, including all expenses except tires and depreciation. Compare that with an automobile trip from hotel to hotel! In the usual run of hotels the costs average $10 a day even if economy is practised; and without care the figure is likely to be $15.

But with the auto-camper, expenses are limited largely to gasoline, oil, minor repairs, and a weekly grocery and meat bill such as he has at home. If about $20 is spent weekly on these items at home, it is probable that on the road costs will be about the same.

Trimming the budget to a dollar a day is difficult but possible. There is no question, however, that expenses can be kept down to $15 or $25 a week for each person. The amount varies, of course, according to the sum spent for amusements and incidentals, such as camera supplies, fishing tackle, and shotgun shells.

WHERE SHALL I GO?

GET a complete change of scenery, that's my advice. If your home is inland and you love the water, try the ocean or the Great Lakes. If you live on the plains, find some hills or mountains.

Good roads, today, are to be found almost everywhere. It is always well to remember, however, that a poor road at 30 miles an hour is often a splendid road at 15 miles. In fact, I have found that, as a rule, the 15-mile-an-hour roads are more interesting because they are less traveled.

On the side roads the view is rarely blocked by a car ahead, and then these less traveled roads are more apt to offer attractive camp sites and better fishing and bathing. I prefer to take the roads as they come; but when I have a choice, I pick the lower road.

In planning a trip, it is well to be sure that the average daily mileage will be not too high. For most of us, 100 miles a day should be the maximum; 75 miles is better. Much of the possible auto-camping freedom is lost in keeping up a stiff mileage schedule. Auto-camping should be vagabondage.

Really, the most satisfactory kind of a trip is to start out aimlessly and wander about from day to day, without a set itinerary and certainly without the necessity of covering a set number of miles. In most sections of the country 75 or 100 miles will bring a complete change of scenery. A small daily mileage permits stops along the roadside to fish or swim, or take advantage of any other pleasant recreation the country offers. Never forget that the primary object of a vacation is to absorb all the good health that Mother Nature offers so abundantly.

CHOOSING A CAMP SITE

IT IS not the easiest thing in the world to pick a camp site. It is unwise to pitch camp in the first field along the road. One field will be passed because of the necessity of trampling some farmer's crop, another because of lack of water, a third because of an abundance of mosquitoes, a fourth because the ground is damp, and so on.

Water for drinking purposes, as well as for washing dishes is essential. So one of the first considerations is a clean water supply — a brook, spring, lake, or well. The true auto-camper prefers a site as far away from human surroundings as possible. A slightly wooded knoll with water somewhere near usually makes an ideal spot.

GET A TOURIST CAMP DIRECTORY

NEARLY all the 2000 camp sites available this summer are listed in camp directories issued by touring information bureaus. Such books contain maps of the United States showing the principal roads and all the camp sites. In addition, the camp sites are described briefly, as for example: "Wausau (Wisconsin), population 20,000. Shelter. Fireplaces. Stoves. Running water. Toilets. Electric lights. Wooded. One mile out. Police protection. Free. No permit required. Information at Chamber of Commerce."

As a rule, these camp sites are equipped with stone fireplaces for cooking, although some have stoves burning wood or coal, and others gas stoves. They are supplied with water and electric light, toilets, rest rooms, laundry facilities, and shower baths. Often fishing and bathing are listed as attractions.

THE CAMPING EQUIPMENT

IT IS not necessary to load the car nor to clutter up its appearance if the selection of the equipment is done scientifically. Perhaps the most important question is, Where to Sleep? One of the newest types of auto-camping beds may be installed right in the car over the seats. It collapses to golf-bag size, weighs only 13 pounds, and can be installed in four minutes. Then there are several types of tents that are largely supported by the car, being placed at one side like a lean-to on a house. For some of these tents the top of the car takes the place of a ridge pole supporting the canvas. The car forms a firm anchorage for the tent and the space in the car may be used as a "front porch" or a dressing room, as you prefer. Other tents of this character are provided with an awning, which gives the effect of a porch in front. This porch is a convenient place for cooking on rainy days and for loafing when the sun is bright. All these tents are designed to fold into a small space and to be erected quickly.

Tents designed to be erected separately from the car may be obtained in a variety of styles and sizes. Most of the modern tents are insect proof. They have canvas floors, screened openings, including windows and doorway.

ADDITIONAL ITEMS

OTHER ingenious camping equipment this year includes numerous types of folding beds and cots; folding camp chairs, folding tables; runningboard trunks that serve as combination tables and cupboards when the tent is up; folding stoves for wood, kerosene, or gasoline; a wide selection of dishes, pots and pans, and other cooking accessories that can be packed into a small space. Some of the most useful of the new accessories are pictured on the opposite page.

Two-wheeled pneumatically tired trailers are convenient for carrying the usual camping equipment. In fact, some of them actually are folding bungalows. In one typical example the bungalow is built on a platform about seven by five feet in dimensions. When folded, the structure has sloping sides like the peaked roof of a house; but when opened, the sides rise to a perpendicular position. The platform is flanked on each side by a double bed with springs and a mattress. The space between the beds serves as dressing and living room. At the front is a compact, two-burner

(Turn to page 87)

Points to Remember on the Trip

BEFORE starting on the auto-camping trip, inspect the car carefully. Be sure it is in perfect repair.

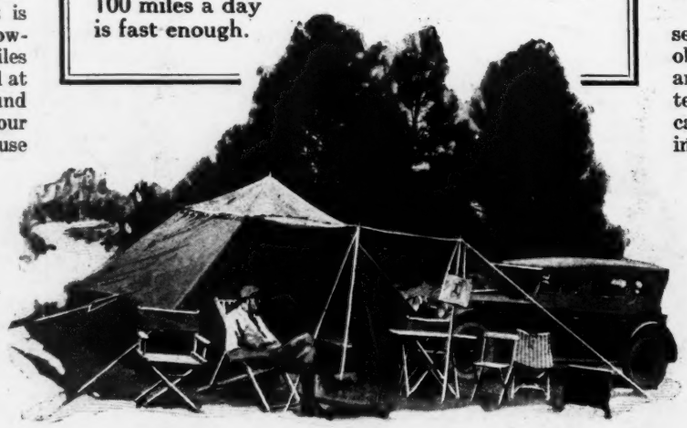
Prepare for any emergency. Carry a collapsible water bucket, tire chains, a pocket flash-lamp, an extra gallon or so of oil, and five gallons of extra gasoline.

Select camping equipment that will pack into the smallest space, yet will provide every convenience.

On the road, as at home, take systematic care of the car. Inspect gasoline tank, oil reservoir, and radiator regularly to see that they are full. Inspect the tires for inflation and needed repairs. Turn grease cups and oil chassis. Change engine oil at least every 1000 miles, preferably every 500 miles.

Drive slowly on narrow or poor roads. Always keep the car under control. Be alert. Obey the laws of the road.

Take your time. To enjoy the trip, 75 or 100 miles a day is fast enough.

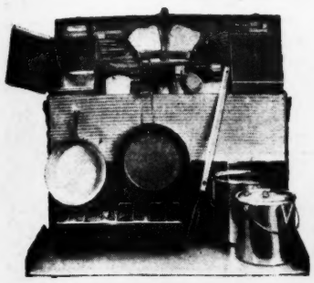


A typical scientific auto camp, 1923 style

New Aids to Auto Camping Comfort

Tent, Beds, Kitchen, and Tables Can Be Packed into Small Space

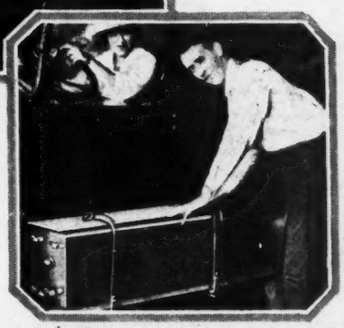
Luscious Meals Cooked on the Road by Engine Exhaust Gases



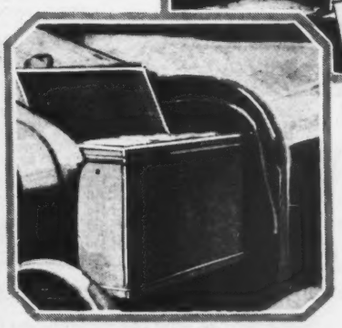
One of the most convenient of all the new auto camping accessories this season is the complete, compact cooking and table outfit shown above. Pots and pans, cooking utensils and tableware, are packed in a small case carried on the runningboard

An iron stake with sharp blade driven into the ground in the center of a fire, serves as a steady support for cooking grids and a coffee-pot hook

A folding table and four folding chairs, which open like umbrellas, can be packed into a case not much larger than a tennis-racket carrier. The table top folds up to form the case. All legs of the furniture are made of steel



This folding table collapses to form a runningboard box in which provisions and utensils can be carried, as shown at right. The top of the box forms a shelf. The table is made up of the bottom and two sides



Each of these two types of auto-cookers, when placed under the hood and on the engine, as shown at the left, are operated by the heat from the engine exhaust gases which circulate about the containers within the cooker itself

By arranging the seat cushions and spreading a canvas sheet over all, as shown below, the Ford sedan can be transformed quickly into a Pullman sleeper

The tent, a table, a bed for two and benches for six fold up into a compact runningboard box (below) that weighs only 150 pounds

Plenty of room for the family in the Ford sedan sleeper. The rear cushion is moved forward and supported on braces. The head rests upon a canvas cushion fastened across the rear

This tent, with screened windows on all sides, is supported by a folding steel framework that is easy to erect and stretches the canvas so that it is windproof and watertight

Equipping the Auto-Camping Car

By George Arthur Luers
Automotive and Mechanical Engineer

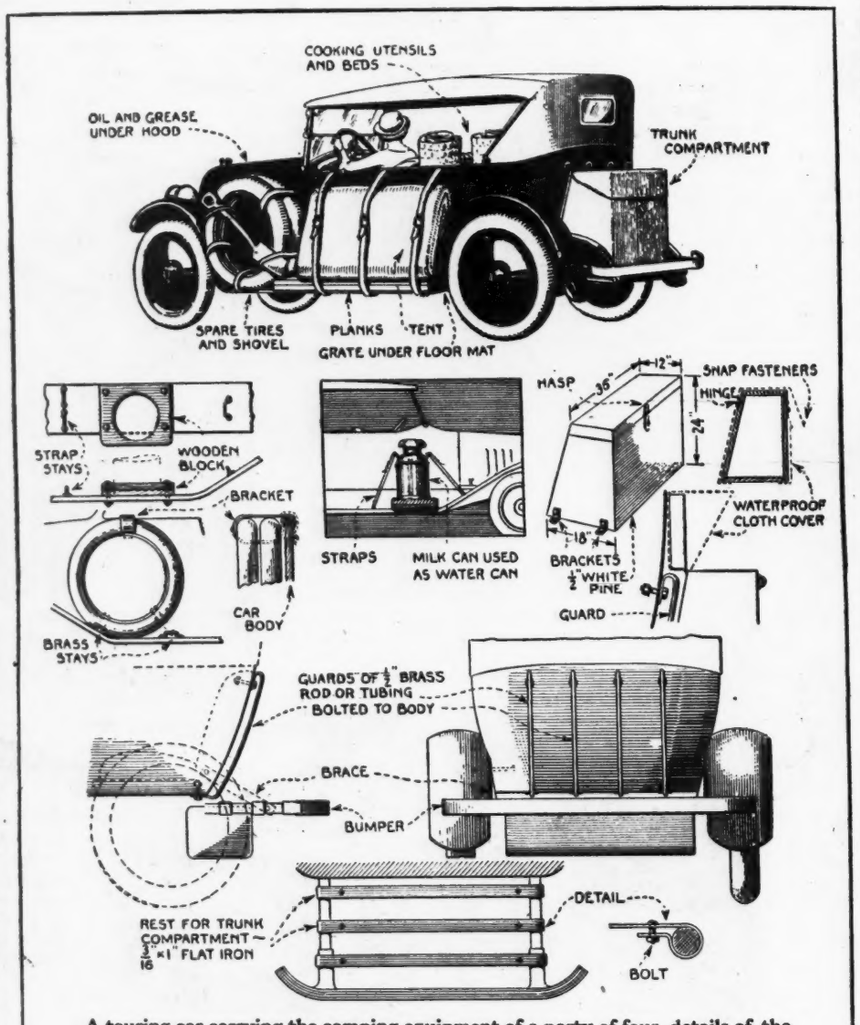
WHAT is the best way to equip your car for auto camping without building a special body or going to any unnecessary expense?

This is a question that confronts thousands of prospective auto campers this summer. I shall, therefore, give in brief outline what equipment is considered essential for a party of four on more or less extended camping trips, and a convenient method of disposing of it about a touring car to the best advantage.

Camping with four in the party is desirable because the services of each person can be utilized for special duties and in that way the work divided up and disposed of in the least time. One person takes care of the car and the mechanical details of greasing, oiling, and adjusting it. Another does the cooking and has charge of the food supplies and cooking utensils. The third person cares for the tent and sees to its erection, dismantling, and stowage, and the fourth arranges for water and firewood, chops sufficient wood to maintain the campfire, and gathers pine boughs for bedding, if used.

These duties must be attended to properly, if camping is to be done in comfort. It is also important that the equipment should be carefully chosen to avoid overburdening the car and yet to forestall breakdowns and other difficulties through lack of the proper supplies.

The equipment in the following list has been carefully selected, and furnishes a good basis for preparing an individual camping list.



A touring car carrying the camping equipment of a party of four, details of the trunk compartment, rear platform, body guards, water can, and tire carriers

Car Equipment

1 shovel
1 gal. oil
5 ft. high tension wire
Folding canvas bucket
Extra hose connection and clamp
Package of waste or paper towels
50 ft. ¼-in. sash cord for lashing
2 extra tires, 2 tubes, 2 blowout patches
Set of tire chains and extra cross links
2 pieces of wood 1½ in. by 10 in. by 4 ft.
Regular tool equipment for the car, including jack, pump and tire tools.
30 ft. ½-in. manila rope
1 lb. cup grease
20 ft. smaller wire
Extra lamp bulbs

Cooking Equipment

Grate 10 by 24 in.
2 baking pans, 10 by 14 in.
Frying pan
Coffee pot
Cooking pot, 10 in.
Food bag or fiber food kit
4 tin or aluminum cups
4 tin or aluminum plates
Knives, forks and spoons
Breadpan
Pot hooks

Tent and Camping Equipment

Tent, 9 by 9 by 7 ft., with canvas floor
2 4-ft. padded canvas mattresses or 4 cots
Camp light or spotlight with wide reflector
4 ponchos
5-gal. water can

Fit the 5-gal. can to the right runningboard and place the grate under the rear floor mat. Mount the tires on the left runningboard. Put the rolled-up beds on end in back of the front seat and stow the cooking utensils between the beds.

The rolled-up tent is carried on the left runningboard; the shovel is strapped to the tires; the cans of oil and grease are carried under the engine hood. Food, clothing, and miscellaneous supplies are packed in a trunk compartment at the rear of the car.

The equipment necessary for accomplishing this can be made quite easily and inexpensively by the car owner himself. The trunk compartment is the most important item. To make room for it, the tire rack is dismounted and either permanent or temporary guard rails are placed on the back of the car. These rails are brass rods, tubing or wrought iron bars ½ in. in diameter, fastened with bolts through the body and the frame of the car. A space of 2 in. between the body and the guards keeps the trunk from rubbing the paint and provides means for lashing on extra bags.

Assuming that the car is equipped with a bumper, rests are placed between the horizontal supports, and extra body braces are added to make a shelf heavy enough to support the trunk. Strips of structural steel, about 3/16 by 1 in., will be found useful for this.

The trunk is a wooden box with hinged top, lock, and cover—made of waterproof leather substitute or rubberized fabric. While dimensions are shown on the detail drawing, they may be modified to suit the available space of your particular car.

The tires are held at the side of the car by strap stays, with a bracket above, as shown, to support them rigidly. The water-can carrier is a wooden block with a recess to take the bottom of the can. Stays are attached to the runningboard so that the can may be strapped in place in the manner illustrated.

Too much attention cannot be given to providing solid stays and stout leather straps to hold everything solidly, for a shifting load adds considerably to the difficulty of driving. It is desirable to provide stays and a strap even for the gallon oilcan under the engine hood.

The camp grate, which is simply a wire or sheet metal grid with removable legs, can be made or bought.

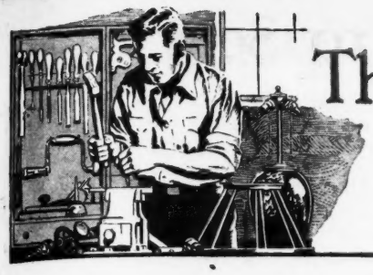
This equipment represents the bare essentials and various additions and refinements can be made to suit individual requirements.

Preparedness is about half the battle in camping; and a definite plan for carrying the equipment, as well as a thorough knowledge of the route and camping sites, will eliminate the hardships that unprepared campers sometimes meet.

A Few Extra Hints

Even with the equipment stowed as described, it is advisable to prepare to camp early in the evening before darkness has come, because ample time is needed to get the camp in order. It is well, also, to obtain permission from the owner of a campsite, in order to avoid being disturbed after the tent is up.

FOR long camping trips and where more elaborate equipment is to be carried, it is desirable to build a special body for the car. How to do this most economically was told in detail in POPULAR SCIENCE MONTHLY for June, 1922, pages 77 and 78.—THE EDITOR.



The Home Workshop
Arthur Wakeling, Editor

How to Build an Iceless Icebox

By Joe V. Romig
Machine-Tool Designer and Builder

THE iceless icebox is one of the latest and best additions to the modern mechanical kitchen. It appeals instantly to every housewife, because it provides a dry, constant cold instead of the moist, variable temperature of the ordinary refrigerator.

With mechanical refrigeration, foods such as meats can be kept sweet and wholesome for a considerable length of time. This reduces waste and allows the economical purchase of meats, butter, lard, and the like in relatively large quantities. As against the cost of ice, the mechanical refrigerator requires, once it is installed, only a small amount of electric current to operate the motor. Consequently the cost of operation is low.

The principal drawback to the installation of an iceless icebox in the average home is the high first cost. This difficulty can be overcome in part by any skilful mechanic who will take the time to make the refrigerating device illustrated. This is connected with any household refrigerator of fair size and can be located either alongside the icebox, as shown, or in the cellar, or wherever convenient.

The machine is relatively simple, especially the combined condenser and receiver, which is my own design. I have built several of them and they are working perfectly. There is, moreover, no complicated automatic control. The machine is run twice a day in the summer and once a day in the fall, spring, and winter for ordinary use, although how much it must be run depends upon the amount of cold lost in use and through opening the box. Being an ammonia type of machine, it is the most efficient from a mechanical standpoint, as is indicated by the fact that large refrigerating plants all have adopted the anhydrous ammonia principle for operation.

A home refrigerating plant keeps the icebox constantly cold and dry

The compressor is the heart of the iceless icebox. For the home icebox of not more than 70 cu. ft. capacity, a compressor of from 1½ to 2 in. bore and stroke is large enough. A machinist can make the compressor himself, if he wishes, but otherwise one should be purchased from a reputable manufacturer. The compressor must be a good one, however, with well fitting piston rings and bearings, and, above all, it must be tight in all its joints. There should be absolutely no leak. Cast iron, steel and Babbitt metals must be employed, as any metal containing a trace of copper will corrode. A neat and serviceable compressor of small size is illustrated on page 97.

The cylinder with the upper valve chamber is cast as one part, and the suction chamber is completed by shrinking a cast iron ring around the turned flanges of the chamber. Ports are drilled into the cylinder proper to allow the descending piston to draw in the gas when they are uncovered. The steel discharge valve covers the whole area of the cylinder top. It is ground to a perfect seat with fine emery and oil and holds the gas under the high pressure of 175 lbs. a square inch without leakage.

To cause this valve to seat promptly when the piston ceases to move at the top of the stroke, a strong spring is employed. Too heavy an action is accompanied by a battering of the valve seat, while too slow an action causes low efficiency through gas leakage back into the cylinder as the piston passes over the top of the stroke.

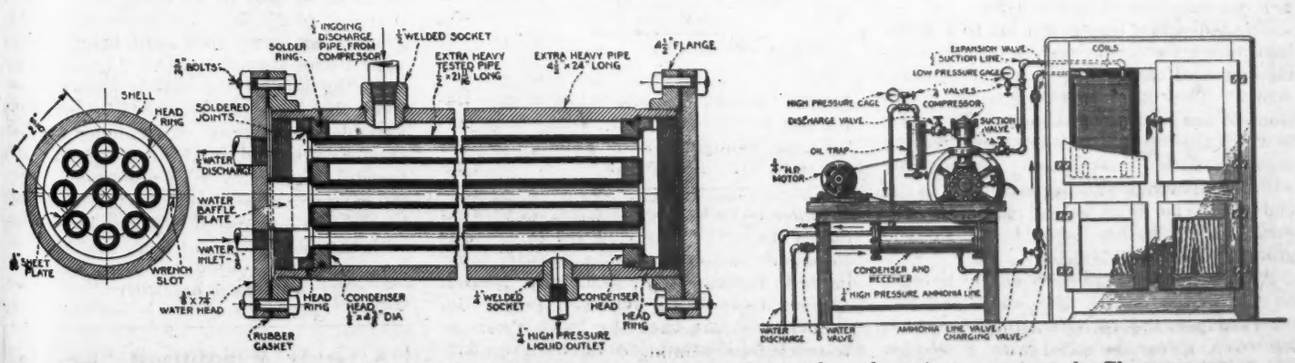
The crankshaft should be made of generous proportions and run in large, well oiled bearings. A packing gland must be fitted at the open end bearing to hold the gas pressure of the crankcase, which does not go higher than the low pressure of the suction side of the machine. The flywheel should take either a ½-in. round belt or a 1¼-in. flat belt. The diameter is controlled by the speed reduction of the motor drive. Compressors should run between 200 and 350 r.p.m., depending on the amount of work required of them.

Lubrication is of vital importance. Most compressors are vertical and are splash lubricated, the oil of the crankcase splashing on the cylinder walls and on or into all of the bearings. Therefore all oil is put into the crankcase, and this is done by putting the crankcase under a slight vacuum.

To do this the machine is run with the suction valve closed for a few minutes, which will usually pump out the trapped air or gas and cause the oil to suck in through an oil charging valve and hose. The oil must be of the best grade ammonia oil, one that will not chill or coagulate. It should have a good lubricating body and also stand the effects of heat without thinning too much. There is only one place to buy ammonia oil and that is from a refrigeration supply house. Any other source is unreliable, and if one should buy the wrong kind, it may cause much unnecessary trouble.

The next unit of the system is the oil trap. Oil will persist in passing up the

(*Turn to page 97*)



Working details of the combined condenser and receiver and a diagram showing how the units are connected. The motor-driven compressor, oil trap, and condenser can be placed near the icebox, in the cellar, or wherever convenient

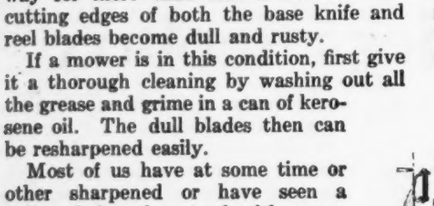
Restoring the Lawnmower to Service

By Robert S. Lewis

TO HAVE your lawnmower sharp and in good condition takes much of the drudgery out of trimming the grass. A new lawnmower or one that has been reground and adjusted, cuts easily and smoothly, but usually it does not stay that way for more than half a season. The cutting edges of both the base knife and reel blades become dull and rusty.

If a mower is in this condition, first give it a thorough cleaning by washing out all the grease and grime in a can of kerosene oil. The dull blades then can be resharpened easily.

Most of us have at some time or other sharpened or have seen a mower being sharpened with emery and oil. The trick is done by smearing a little emery and oil on the base knife and rotating the driving wheels in a reverse direction by changing the palls or ratchets so as to drive the reel blades backward, and also by running the mower backward and forward on a cement sidewalk.



Wire-wound round tread and sharpening handle (at left); method of repairing broken tread (at right)

It will not be necessary to buy a quart of oil and a pound of emery to do this little job; simply use your box of valve-grinding compound. Smear on enough to cover the shiny part of the base knife and add a little as the emery wears away.

File Is Not a Good Sharpener

Amateur mechanics sometimes attempt to sharpen lawnmower knives with a file, but, although I have repaired and resharpened many a lawnmower, I make it a practice to have nothing to do with one on which a file has been used.

When regrinding your blades, be sure that you make the adjustments true and straight. The base knife should be screwed up until it touches evenly all the way across, with the same pressure on each reel blade. If the reel is not set up snugly enough to take up all the lost motion in the bearings, it will not sharpen evenly, as on slow speed it will push away from the base knife and on high speed the centrifugal force will throw it off center. In that case, tighten the cones so that they will rotate freely yet without any "shake."

Personally, I prefer to sharpen a lawnmower by holding the cross bar in a heavy vise and either turning the wheel by hand with the handle shown or by belting it to a rather slow-running countershaft.

When changing the palls back to their proper pinions, note whether they are in good condition. If not, either buy new ones or make them out of steel.

Grease all moving parts with vaseline or cup grease. Then reassemble and make all the adjustments snug, pulling up the locknuts on the base knife bar adjustment with a wrench and not simply pliers. Then paint the mower with green and red enamel or paint and give the handle several coats of spar varnish. The paint will preserve the metal and prevent rusting. Incidentally, it will make the mower look like new and, let us hope, cause your neighbors to hesitate to ask you for its loan.

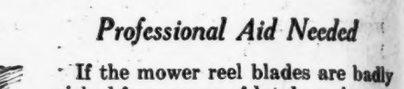
The treads of the driving wheel are sometimes broken between the spokes by careless use. This can be repaired by fitting two hardwood plugs into the broken space, as shown. For a more substantial repair, build up a clay mold and fill the cavity with lead or Babbitt metal.

If a mower has insufficient traction to cut heavy, tough grass, wind a piece of soft, thick wire around the tread, as illustrated. Before attempting to cut a high-grown lawn, pick out any rocks and tin cans, and cut down the grass roughly with a scythe or sickle.

Professional Aid Needed

If the mower reel blades are badly nicked from years of hard service and abuse, send the mower to a good repair shop to have the blades ground on a machine especially designed for this work.

Incidentally, when buying a new mower, choose one according to your size. A 14-in. mower is more suitable for a small, light-weight man than an 18 or 20 in. machine. Mower reels may have from three to five blades, depending upon their size and price. Select one with the larger number, if you wish a long lived machine.



Before putting the mower away, always wipe the base knife and the blades with an oily rag to prevent their rusting.

If the mower is regularly oiled and kept clean in this way, it will remain sharp for a long time and rarely need repairs.

Radio Set with "Sectional" Panels

AFTER the amateur radio fan has completed his first set, he usually reconsiders the layout of the instrument and wishes he had done the job differently.

To obtain flexibility in connection with a homemade cabinet set, it is necessary simply to use several individual panels, one for each instrument or unit. Any panel can then be taken out of the cabinet and a new one substituted at any time.

The individual panels are cut to a width that allows a generous margin for any overlapping and projecting parts of instruments. They slide in two grooves in the front of the cabinet, as shown. The piece in which the top groove is cut forms the top member of the front frame, and is fitted with a loose tongue-and-groove joint to the end posts, so that it can be lifted out easily. The panels should fit in the grooves without binding.

All the panels should be neatly beveled on the vertical edges with a file and fine emery paper and oil. If a blank space is left over, it can be filled with a wooden panel of the same kind of wood as the body of the cabinet.

The economy of small panels will appeal to every builder of a set, but even more important is the extreme flexibility they permit in changing and adding to the set.—M. G. C.

Sliding unit panels give unusual flexibility

TO FIND out whether crackling and frying noises are in the receiving set or are due to outside factors, leave the vacuum tubes lighted, disconnect the aerial and ground, and see if the noises persist. If they do, the chances are that the trouble can be traced to bad connections or run-down batteries. If the noises stop, they were probably due to re-radiation by a neighbor's set or other causes difficult to control.

Small Brass Gear Serves as Radio Dial Vernier

A SERVICEABLE geared Vernier dial for the radio fan who prefers to make his own instruments as far as possible, can be constructed by using a small brass gear and pinion.

The dial itself is nothing more than a 120-tooth brass gear of 48 pitch with a pitch diameter of 2½ in. Its fine teeth serve as graduations, every fifth tooth being marked with a steel stamp, 1, 5, 10, 15, and so on.

In the hub of the dial is placed a setscrew that binds the gear to the shaft of the variable condenser or variocoupler or variometer rotor, and to the hub is fastened a knurled brass knob or, if preferred, a regulation composition knob. I use a knurled brass knob because it is more in keeping with the metal dial and helps make my set look unlike the average conventional set.

(*Turn to page 103*)

A variety of additional "how to make" radio articles will be found on the pages following page 103

Rigging a Sail for Your Canoe

THE owner of a paddling canoe never realizes the full enjoyment of canoeing until he has added a sailing outfit to his equipment. This is not difficult to do, and the material for a homemade outfit costs less than buying the equipment from a sporting goods store.

The sailing rig illustrated is neat, substantial, and exceptionally serviceable. The original outfit, made by Henry S. Laraby, of New Haven, Conn., has stood the test of seven March to November seasons of unusually hard sailing, during which 7000 miles were covered. It has sustained winds that ordinarily no canoe sail would be expected to withstand. Since building it, Mr. Laraby has made 10 others for friends who admired the rig, and those outfits are giving equally good service.

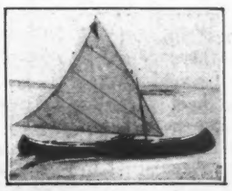
When making his own rig, the canoeist usually encounters difficulty in mounting the mast. Often a piece of wood is screwed to the rails and a block is fastened to the ribs for a mast step. This is bad practice, because the screws will pull out, and the holes mar the rail and leave the ribs weak. It is, indeed, a makeshift idea, with no great strength.

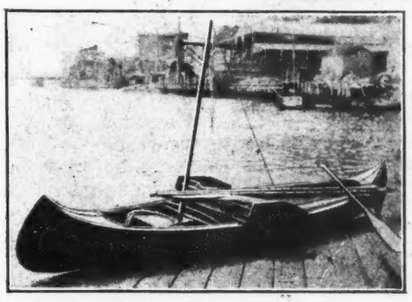
The method of mounting the mast shown calls for more work, but any dyed-in-the-wool canoeist is willing to expend a little time and effort in order to have the best looking and best sailing canoe. The general method of constructing the mast step is made clear in the details. The main member is a solid bulkhead fitted to the canoe. The bevel of the edge of the bulkhead changes from bottom to rail, so that it is necessary first to make a mold of rough wood to obtain the correct shape and bevel. The bulkhead and other wooden parts are preferably solid mahogany, ⅞ or 1 in. thick.

Mortised to the bulkhead are a top board and a baseboard of the shape shown. The boards project ½ in. through the bulkhead and are bolted fast by means of intermediary blocks. The lower blocks, it should be noted, are bolted to the baseboard before it is put in place.

The top board has a 2-in. hole for the mast, and a square block with a 1½-in. hole is located on the baseboard with the mast in place. The front board, which, to save space, is shown directly at the right of its sectional view in the accompanying mechanical drawing, is shaped as indicated and fastened by means of blocks to the top board and baseboard. Galvanized iron bolts ¼ in. in diameter, with washers under the nuts, are used wherever bolts are shown. It will be seen that the boltheads in the baseboard are countersunk. The halyard pulley is hooked to an eyebolt, placed as shown, in the top board.

To fit wings to a paddling canoe is as pleasant a job as ever comes into the home workshop. Full working details and bill of materials for a sailing outfit like this will be found on Blueprint No. 25 of the Home Workshop series of blueprints





The mast mounting unit is held by means of three bolts, one in the plain thwart and two in the seat thwarts. These holes do not weaken the thwarts, since they are well backed up underneath by the rigid construction of the mast step.

The fixture can be put in and taken out quickly by unscrewing the bolts, although it will not loosen by itself in the hardest kind of a blow. That is because the strain is distributed over the greatest possible area—the bottom, sides, rail, thwarts, and seat.

Made in this way, the mounting for the mast looks like part of the canoe and adds to its value if the owner ever wishes to sell. The wood can be left unstained and given three coats of spar varnish. The name should be placed on the bulkhead, either in gold or carved letters.

The leeboards also are an improvement over the usual friction type. They do not work loose, they stay down by themselves and are raised together. The objection is sometimes heard, however, that having both boards down at the same time acts more or less as a drag, but Mr. Laraby's experience has been that this type is satisfactory. It offers more than the usual antislipping surface and, at the same time, when starting or landing in any kind of rough water, it is not necessary to run forward and pull up and push down the boards.

A stick across the canoe rails holds the boards up, and, when launching in a surf, a pull on a string connected with the stick will drop both boards at the right moment while the canoeist remains seated in the bottom of the canoe.

The boards are made of the shape and size shown, the main taper beginning 1 in. below the hinge. They are braced to the cross support or spreader by two strips of brass, bent as shown, and attached by ¼ by 2 in. brass bolts and wingnuts. Brass plates ⅛ in. thick and 1½ in. square are riveted on both sides to the boards and to the spreader at the points where the brace bolts pass through.

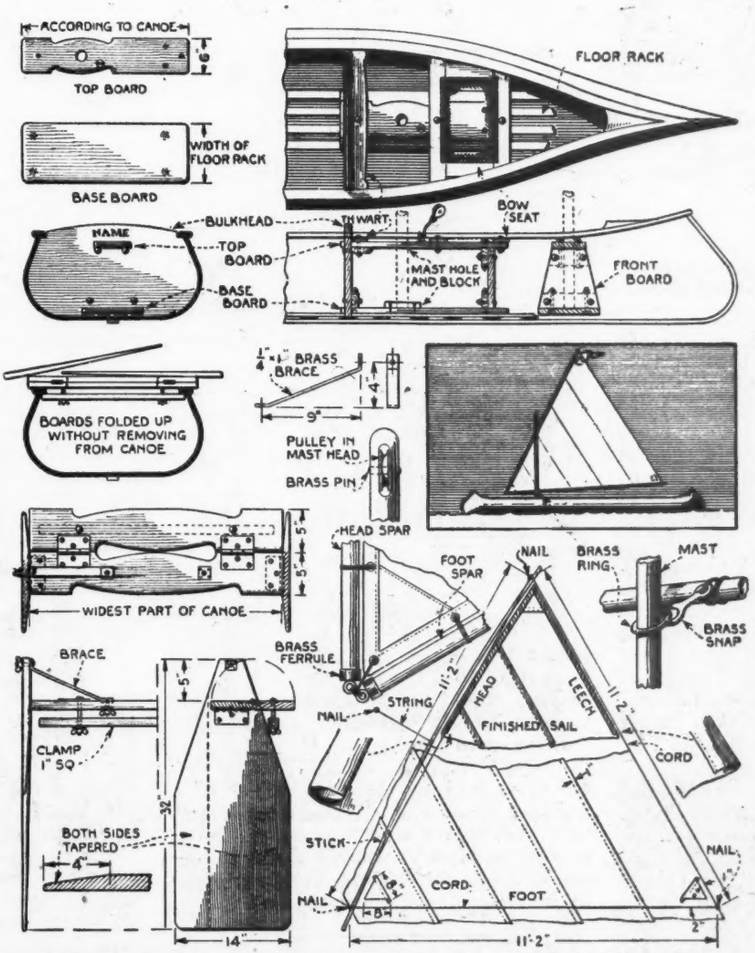
Brass or galvanized iron hinges 4 in. long are used; they are set flush in the wood and riveted with 3/16-in. brass stove bolts. The cross bar is held in place by means of a 1-in. square clamping piece and bolts and wingnuts.

If it is desired to save the expense of genuine mahogany, white pine or cypress may be used instead, and left bright and varnished.

The sail, which is made of 8-oz. canvas or light drill, is laid out on the floor, as shown. Three nails are driven in the floor at points 11 ft. 2 in. apart to form a triangle and connected with a string. A stick or shingling lath is brought to bear against two of the nails and, by means of a short length of cord tied to the center, it is bent out 2 in. like a bow. This is to give a line for cutting the head of the sail that will allow for the bending of the head spar.

The cloth is cut roughly at first, about 2½ in. outside the cord, and then sewed together in strips parallel to the leech. The sail is next trimmed to the lines formed by the string and stick. The corner pieces are pinned on, the edges of the sail are turned over to

(*Turn to page 100*)



Showing method of mounting the mast by means of a solid bulkhead and a substantial framework, the construction of the leeboards, and how the sail is made and attached to the spars

Scooter Adds Thrills to Swimming

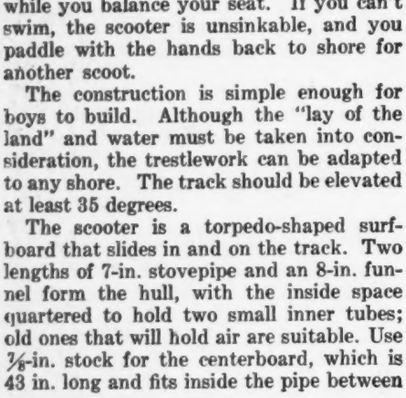
By Roland B. Cutler

THRILLS and safety seldom "keep company," but a dive down this scootaway is safe fun for bathers of all ages.

You are all set for the first trip. One heel lifts the starter slightly and you make a breathless swoop and a long, shallow dive, while you balance your seat. If you can't swim, the scooter is unsinkable, and you paddle with the hands back to shore for another scoot.

The construction is simple enough for boys to build. Although the "lay of the land" and water must be taken into consideration, the trestlework can be adapted to any shore. The track should be elevated at least 35 degrees.

The scooter is a torpedo-shaped surfboard that slides in and on the track. Two lengths of 7-in. stovepipe and an 8-in. funnel form the hull, with the inside space quartered to hold two small inner tubes; old ones that will hold air are suitable. Use ⅞-in. stock for the centerboard, which is 43 in. long and fits inside the pipe between



How the upper part of the track is built, and details of the "starter"

the boards that plug each end. Side boards are attached to the center board with a 2¼-in. space at each end to allow an inner tube to bend around each side board.

Each runningboard is cut from ¾-in. stock, 5½ in. wide, with a 3-in. board underneath set 1½ in. from the outside edge and braced with 3-in. corner irons at the ends and center. Attach these with strap iron—a mending plate, ⅞ in. by 18 in. long—to each boarded end of the hull, centering them at right angles to the center board. At the front a funnel, minus its neck, is fastened with a strip of sheet steel, a long stovebolt, and a washer.

The seatpost is ⅞-in. stock, 4 by 10 in. high, set back of the hull joint and fastened over the center board with 4-in. corner irons. The rear half of the seat drops 1 in. for easy riding.

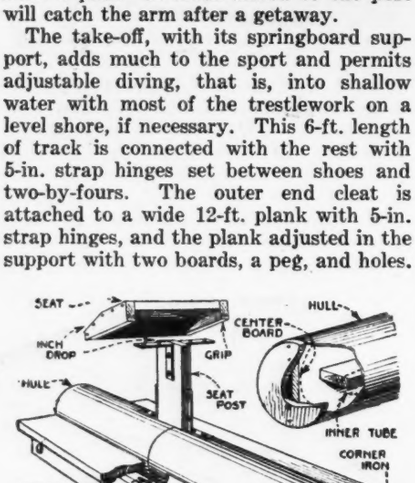
At the ends and center of the "trough" outside of the runningboards, attach 1⅛-in. sliding casters to engage the inside and top of the track, six sliders to a side.

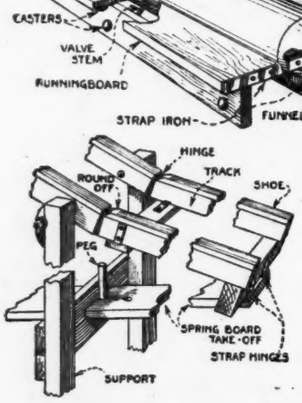
The track can be built entirely on the ground. Use two-by-fours planed on the inside with ¾ in. by 2 in. wide shoes, such as hardwood flooring, and ⅞-in. stock for the cleats, which are spaced about 18 in. apart. The inside width of the track must be 15 in. Notice how 4-in. corner irons are fitted at every cleat. Fasten the shoes with eightpenny finishing nails, toenailed into the top edges and set. Erect the track with 5/16-in. bolts, as shown.

The scooter is slid up under the starter and safely held until you're "all set." This

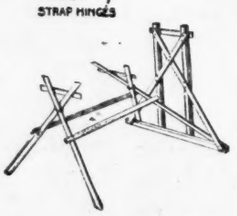
starter may be right or left, and requires ⅞-in. stock—an arm 4 by 26 in. long, a 2 by 7 in. button to engage the seatpost, and a heel lift shaped from a 5½ by 10 in. board. Hinge the arm as indicated with a 3-in. butt, 5 in. above the track and 3½ in. from a post. A block nailed to the post will catch the arm after a getaway.

The take-off, with its springboard support, adds much to the sport and permits adjustable diving, that is, into shallow water with most of the trestlework on a level shore, if necessary. This 6-ft. length of track is connected with the rest with 5-in. strap hinges set between shoes and two-by-fours. The outer end cleat is attached to a wide 12-ft. plank with 5-in. strap hinges, and the plank adjusted in the support with two boards, a peg, and holes.





The scooter (above), the hinged take-off (at left), and diagram of trestlework (below)



Secure the loose end to prevent side-thrust.

Lubricate the shoes with oil or graphite and keep the casters well greased to prevent rust. On a long scoot a short paddle is handy, the blade of which can rest at the rear of the scooter with the handle gripped by a wire coathook under the seat.

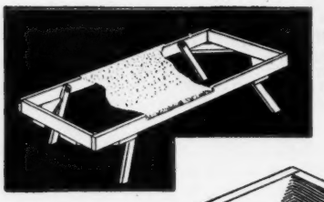
IN TESTING a radio set, an unmistakable click should be heard when the phones are connected and disconnected, when the grid and one of the filament posts of the set are touched at the same time, and when the aerial and ground posts are touched simultaneously. Be sure that the socket springs make good contact with the tube prongs.

Child's Camping Cot Can Be Made Quickly

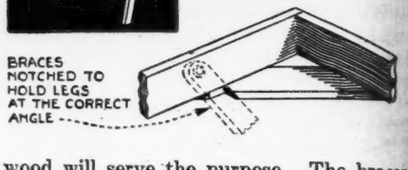
ONLY 12 pieces of wood are required for the frame of this light but strong child's cot. Made for temporary use, it is standing up surprisingly well and makes an excellent cot for camp use. When the legs are folded in, the frame is used as a shallow box for packing blankets and similar equipment.

The cot illustrated is 2 ft. wide, 5 ft. long, and 1 ft. 6 in. high, but the dimensions can be modified to suit other requirements.

The frame is 1⅛ by 3¾ in. pine, the legs ⅞ by 1⅜ in. oak, although ash or any hard



Twelve pieces needed for frame

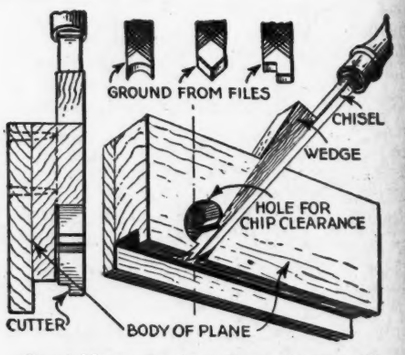


wood will serve the purpose. The braces are 1⅛ by 3¾ in., screwed on diagonally and notched, as shown, to form stops for the legs, which are fastened to the side rails with ⅜ by 2½ in. carriage bolts. To support the mattress, 10-oz. duck is fastened on to the frame with heavy, tinned tacks.—A. E. ELLING.

Chisel Serves as Plane Blade for Special Work

OCCASION arrives in every home workshop when a special plane is required of some shape other than those at hand. If the expense of a commercial plane is not warranted by the amount of work to be done, it is possible to make up a simple plane from two blocks of wood and a chisel, as shown. Even an old flat file can be ground to serve as the blade.

The block for the body of the plane should be selected hard wood and square and well smoothed on the lower face. A hole is then bored partly through the block to serve for chip clearance and a tapering slot is sawed across the side of



A quickly made plane for cutting small special rabbets, grooves, and moldings, with a chisel or file for a blade

the block to a depth corresponding to the width of the cutting tool. A wedge holds the chisel or cutter in place. Another piece is tacked against the opposite side of the improvised tool to serve as a guiding fence.—G. A. LUERS.

Concrete Fountain Is Cheaply Built

By Roland M. Knight

TO BUILD an attractive garden fountain, and benches, pillars, and curbing of concrete is not particularly difficult and costs surprisingly little for materials.

Those illustrated were made in spare time by the writer and a companion in a few weeks at a total outlay of $17.50, mostly for cement. Gravel was obtained on the property, a California ranch, and old lumber used for the forms.

The fountain is fed from an elevated water tank and the pool is stocked with goldfish and water plants. Almost every morning birds can be seen splashing in their bath just above the pool.

To avoid the cost of a wooden form set in the ground, the ground itself is used as a form. That is, a round, smooth trench 6 in. wide and, in this case, 6 ft. 9 in. in diameter, and 2 ft. deep, is dug and filled with concrete so as to leave the top of the wall perfectly level with the ground. The mixture we used was simply one part of cement to six parts of gravel, although the customary mixture for watertight concrete is one part cement, two parts sand, and three parts aggregate.

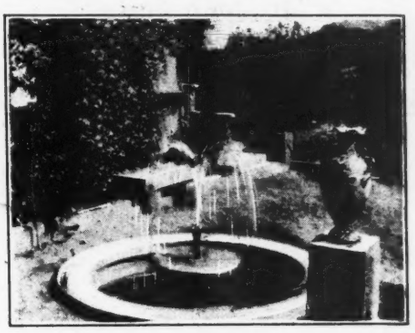
After the wall hardens for three or four days, dig out the earth inside the circle, clean the concrete, wet it well, and plaster it with a mixture of three parts fine sand to one part cement, smoothing it with a wet brush.

The form for the bird bath is made by fastening together 1-in. boards with cleats and sawing out a disk 28 in. in diameter. In the exact center a 6-in. hole is sawed. A strip of smooth, heavy tin 4 in. wide is tacked around the edge of the disk so that it extends 3 in. above the upper surface of the boards.

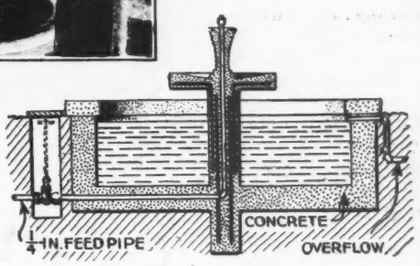
Next, dig a hole in the ground in the center of the pool 6 in. in diameter and about 12 in. deep. Set in it two or three lengths of 6-in. stovepipe, according to the height desired, and put in several pieces of old iron rods or pipe for reinforcing. Fit the bird bath form on top of the stovepipe and brace the whole from the ground firm and level.

To reinforce the bird bath, bend about half a dozen strong iron rods at right angles and let one end of each piece extend down into the stovepipe and the other end point out into the form. Then lay a piece of heavy wire around the form near the edge for additional strength.

Put in a ¼-in. water pipe for feeding the fountain and let it extend about 12 in. above the bird bath. Pour moist concrete made with gravel into the stovepipe,



and fill the bird bath form with concrete made of fine sand and cement. Then whittle the edge of a small board of hard wood to the shape of the depression to be made in the top of the bird bath and, the day after pouring the concrete, fasten one end of the stick to the ¼-in. pipe in the center and scrape around and around until the hollow is about 1 in. deep.



Stocked with goldfish, this fountain is the center of interest in a lovely California garden. The sectional diagram explains the construction

Fill the bottom of the pool with coarse concrete 5 or 6 in. deep and pour on a top layer 1 in. thick made of one part cement and two parts fine sand. After three or four days, remove the forms from the bird bath and pedestal, the stovepipe being taken off by unfastening the seam with pincers. It is advisable to put a concrete collar around the bottom of the pedestal to assure rigidity.

The rim of the fountain is made in eight sections cemented together when placed in position. The one illustrated is 9 in. wide, 4 in. high, and 7 ft. in outside diameter. Put in an overflow pipe before placing the rim.

The form for the one-eighth section was made at a woodworking mill and cost but a few dollars. Any shop with a bandsaw can make this form if furnished with a pattern.

The easiest way to make a pattern is to draw a right angle on the floor and drive a nail through the end of a long slat into the corner of the angle. With a pencil fastened at the other end of the slat make a quarter circle of the correct radius and cut it in two to give the exact pattern for the one-eighth section.

The ornament on the bird bath was made by first casting a cylindrical piece of concrete around the water pipe and the next day, while it was still quite soft, scraping it around and down to the desired shape.

By the time the fountain is finished, the seats will give little difficulty. Simply build wooden forms and fill in with concrete. Any irregularity caused by the use of old lumber can be removed by scraping before the concrete is very hard, or using a cement plaster.

Do not let concrete harden too rapidly or it will crack. Take great care in removing the forms, since half hardened concrete is easily broken. If it is in the hot sun, cover the concrete forms with burlap sacks and keep them dampened for a few days.

Water lilies and other water plants may be grown in the pool. A narrow flower bed just opposite the rim of the fountain adds to the ornamental effect.

Photos Given Realistic Depth by Toy "Stereoscope"

By Dr. Ernest Bade

DO YOU know that looking at a photograph with only one eye gives the effect of depth and distance similar to a stereoscope? Try it by closing the hand to make a narrow tube, holding it to one eye, and looking through it at a photo placed about 2 ft. away. Keep the other eye closed and take care that only the picture and none of the surroundings are seen, for otherwise the effect is spoiled.

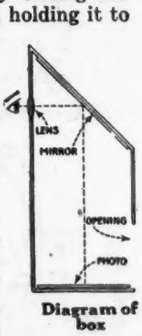


Diagram of box

This stereoscopic effect, which, of course, is only apparent, can be explained by the fact that the ordinary camera has only one eye, the lens, and the picture seen by it is a true picture of what is observed, so that when the resulting picture is seen with only one eye, the photo appears to stand out realistically.

This principle makes it possible to construct very simply and easily a stereoscope

In making a box for the toy "stereoscope," the parts are cut out as shown and glued together with tape at the corners

for the children. All that is necessary is a cardboard box about 1 ft. long, a cardboard frame, a double convex lens, and a mirror.

The box is made as shown, and a ¾-in. peephole is cut in the front near the top. The near side of the box has a large opening close to the bottom; this should take in about one third of the entire length. The top slopes downward toward the back at an angle of 45 degrees.

A mirror is fastened firmly to the top of the box in such a way that the image of a photo placed at the bottom of the box can be seen through the peephole. When the mirror is in place, glue the box together and cover with ornamental paper.

The lens should have a focus of at least 10 or 12 in. Often a double convex spectacle lens that has been discarded can be found in the junk box, and this will serve if nothing better is at hand. Fasten the lens to the peephole.

When the box is ready, place a photograph, a postcard made from a photograph, or a magazine photograph in the bottom and look at it through the lens. The effect will be the same as if a stereoscope was used with two lenses and a double photograph.

The photo is placed in the bottom of the box

If a reproduction of a painting or wash drawing is used instead of a photograph, the result will not be the same, because an artist draws and paints objects as he sees them with both eyes open.

Better Shop Methods

How Expert Mechanics Save Time and Labor

Drilling Accurately by Short Cut Method

By John Aures

THE use of locating buttons is undoubtedly the best method for locating and boring holes when the holes must be accurately placed, yet it has the disadvantage of being the most expensive. It always means the expenditure of much time and labor. A great many small jigs are, of course, made for drilling clearance holes in work, especially when a limit of .005 in. in the location of the holes is sufficiently close. But the average mechanic necessarily has recourse to his height gage and buttons, although he may have a working limit of several thousandths.

As I had much work of this nature to do, I originated a method of laying out and drilling holes in small work to within a limit of but a few thousandths, using only simple tools.

The tools used are but simple ones—a surface gage, magnifying glass, dividers, scriber, scale, center punch, and a light hammer.

Good Magnifier Essential

My magnifying glass has a hole drilled in the end of the handle so as to fit tightly on the scriber on my surface gage (Fig. 1). The dividers, which are of the round-leg variety, are ground to a fine, true point. Occasionally I use a pair of draftsman's dividers, using needles for the points. The center punch is ground on a universal grinder to a 60-degree point. It is very important that the dividers and center punch be kept perfectly sharp.

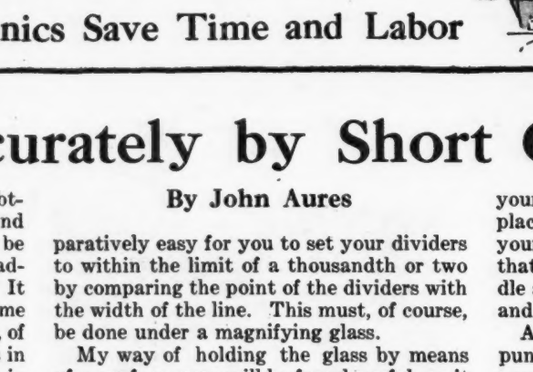
For lines that must be scribed close to the edge of a scale or straight edge, I use the scriber shown in Fig. 2. This is made of a piece of ⅛ by ¼ in. tool steel about 4 in. long, one side of which is ground flat on a surface grinder and the other side beveled off to about a 20-degree angle. The sharp edge has a slight radius. For most scribing, however, I use a metal pencil holder of a standard refillable type, in connection with needles of a suitable size. This makes an ideal scratch awl, as the points are quickly replaced when dull.

In addition to the scale in general use, which reads from sixty-fourths up, I find one graduated in hundredths and fiftieths to be indispensable. The lines on some of the scales are about .005 in. wide. This, however, is not always the case and is not so on scales graduated in hundredths. But the width of the lines, which must be known, can easily be found out.

The way I accomplished it was to collect a number of hairs, both human and animal, and, laying them beside some of the lines on my scale, I compared them under a strong magnifying glass. A difference of a thousandth or two between the hair and the line can be seen plainly. Having found a hair that compared in width with the lines, it was necessary only to "mike" it to get the width of the lines.

Knowing the width of the lines, it is comparatively easy for you to set your dividers to within the limit of a thousandth or two by comparing the point of the dividers with the width of the line. This must, of course, be done under a magnifying glass.

My way of holding the glass by means of a surface gage will be found useful, as it permits the freedom of both hands.



The surface gage, magnifying glass, scriber, and drills used, and (at Fig. 3) the method of keeping the center punch exactly vertical

Start laying out the holes in your work with the one nearest the center and then, if possible, lay out the rest of the holes from this point. As you scribe off your lines you can feel with the point of your dividers where the lines cross and, with a little patience, scribe from there without shifting from the lines.

After all your holes have been laid out, give each one of them a slight center-punch mark. When making the marks it is very important that the center punch be held perfectly vertical. In order to do this, I fold the spindle across the back of my surface gage and stand it on end, using the V-shaped groove at the bottom of the gage for holding the center punch straight (Fig. 3). Feel where the lines cross with the point of your center punch and, holding the punch in place, bring the surface gage against it. If your work is too small or of such a nature that the gage cannot be placed on it, straddle a small pair of parallels across the work and place the gage on them.

After giving the locating points a slight punch mark, examine them closely with your glass. You will very likely find your mark in the very center of your line. If off but a thousandth or two, the divergence can plainly be seen with your glass. Go over your punch marks about three times, examining them each time with your glass. If a heavy punch mark were to be made at the offset, it would be infinitely more difficult to correct than a slight one, if any correction should be needed.

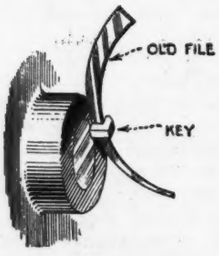
Having laid out all your holes correctly, you are ready to drill them. All your careful laying out will be of little avail if the following directions for drilling are not adhered to closely.

Start drilling your holes with a drill smaller than the outside diameter of your center-punch mark. The punch mark preferably should be made to receive about a No. 52 drill. The reason for this is that the punch-mark has a slight burr around the edge and if the lips of the first drill used were to come in contact with the burr, the drill would be almost certain to deviate from its proper course.

Drill to a depth of ⅛ in. (Fig. 4). Next, take a No. 31 drill and grind the lips to an angle of 70 degrees. Your punch marks are, of course, 60 degrees. This drill, therefore, will cut into the sides of the hole already drilled before coming into contact with the center punch burr (Fig. 5).

Now take a center drill, the drill part of which should be ⅛ in. in diameter. This will just fit the hole snugly and act as a pilot for the countersink part (Fig. 6). Countersink the holes with this until slightly larger than the drill and reamer that will be used for the finished holes. Check up your holes and you will be surprised at having attained an accuracy you never thought possible with such simple tools.

A Crescent-Shaped Key Puller



A GOOD puller for gib-head machine keys can be made from an old 12-in. file forged to shape shown. The edges should be ground smooth.

The tool is driven under the head of the key in the same way as a wedge, but it is superior to the wedge or chisel commonly used.—J. U.

Indexed Box Keeps Drills Sorted

By Henry S. Laraby
Tool and Die Maker

MACHINIST and home mechanic alike will find this novel holder for small drills a time saver in locating the right drill. By turning the top so that the desired number on the dial comes opposite the arrow mark on the case, and by shifting the knob to one of four possible positions, an outlet hole is automatically brought opposite the compartment in which the required drill is to be found. A careful study of the details in Fig. 1 will show more clearly how this can be accomplished than can be explained in words.

The parts are comparatively few and yet, when properly indexed, the box will keep the small drills sorted and ready for immediate use. The metal parts are made almost entirely of brass and the body of the box is wood.

Turn a shank on a piece of brass 3¾ in. in diameter and 4 in. long. True the outside and face it off (Fig. 2, *A*). Remove it from the chuck and saw disks Nos. 3 and 4 from 3/32-in. sheet brass, making them 3/16 in. over the size of the finished diameter. Sweat these with solder centrally to the face of the large brass piece. Rechuck the piece and turn and bore the disks to size. Then use heat to remove them without bending.

Next, turn the outside of collar No. 1 (see *B*, Fig. 2) and stamp the arrow on it before boring the inside. Bore the inside to 2 15/16 in. diameter and, after polishing with emery cloth, cut off the collar.

Turn the outside of cover No. 2, as at *C*, and smooth with emery cloth, but do not bore out. Put the piece in the indexing head chuck and scribe 20 lines, as shown, on the circumference, taking care not to make the lines too deep, and bevel the edge. Remove the piece, mark the lines on the bevel, and stamp the drill sizes.

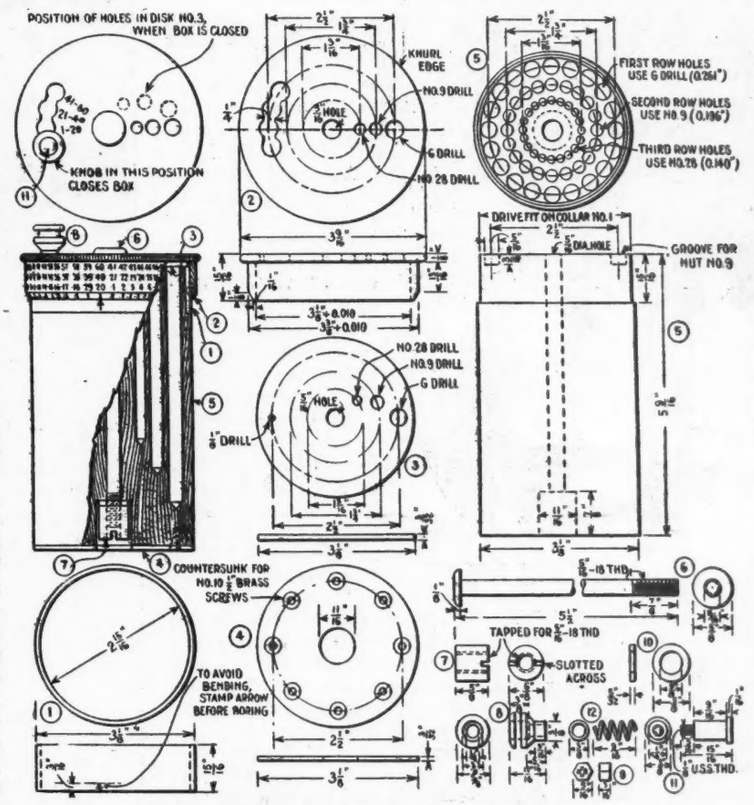

POSITION OF HOLES IN DISK NO.3 WHEN BOX IS CLOSED
KNOB IN THIS POSITION CLOSES BOX
KNURL EDGE
NO.9 DRILL
G DRILL
NO 28 DRILL
FIRST ROW HOLES USE G DRILL (0.261")
SECOND ROW HOLES USE NO.9 (0.196")
THIRD ROW HOLES USE NO.28 (0.140")
DRIVE FIT ON COLLAR NO.1
GROOVE FOR NUT NO.9
COUNTERSUNK FOR NO.10 BRASS SCREWS
TO AVOID BENDING, STAMP ARROW BEFORE BORING
TAPPED FOR
SLOTTED ACROSS
USS THD.

Fig. 1. Working details of the drill box. It not only holds a large number of drills, but automatically selects the one needed

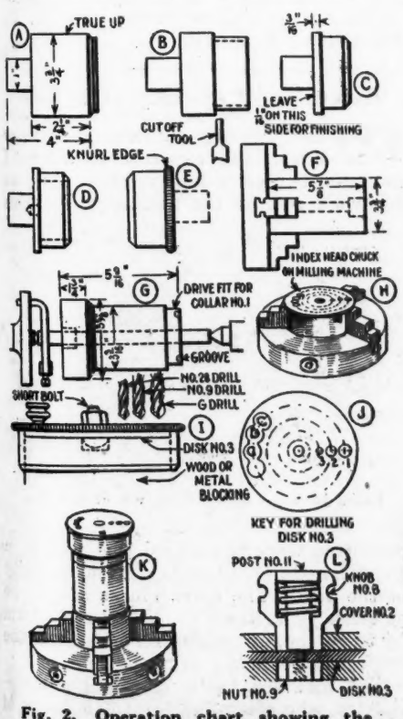


Fig. 2. Operation chart showing the order of steps in machining and assembling the drill box parts

Turning the Wooden Body

Rough out a wooden block in the lathe chuck, as shown at *F*, Fig. 2, and bore a 5/16-in. hole through the center. Face off the end and bore a recess for nut No. 7. Put the wooden piece on an arbor, as at *G*, and if loose, swell the hole with a little water. Turn off the ends to length and turn 1/16 in. over size at the ring end. Leave the base end over size for chucking and turn a recess for collar, No. 1, so that it will be a tight fit. Also turn a groove for nut No. 9 (see groove in No. 5, Fig. 1).

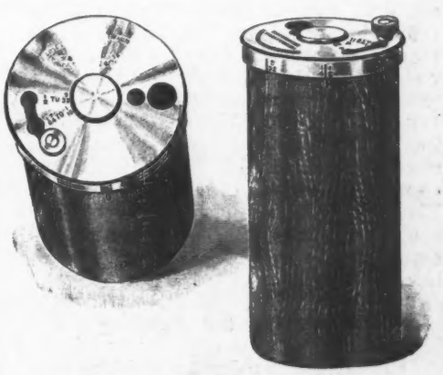
The next step, as shown at *H*, is to put cover No. 1 in the indexing head chuck set for 20 divisions and spot for the seven holes on the circle already scribed. Drill through these spots first with a 1/16-in. drill in the vertical head and then follow with the drill called for. Mill out the ¼-in. connecting slot ¼ in. wide, as shown in No. 2, Fig. 1.

Bolt disk No. 3, as at *I*, Fig. 2, in place inside the cover, No. 2, and place the knob, No. 8, in any one of the ⅜-in. holes. The ⅛-in. hole in disk No. 3 is then spotted with a ¼-in. drill, after which the knob is removed and the ⅛-in. hole drilled. The blocking placed in the cover for this operation is removed and the knob No. 8 is bolted in place on disk No. 3, as at *L*.

With the knob in place on disk No. 3, and the disk in its place in the cover, No. 2, and the short bolt also in place, drill the holes in disk No. 3 through the holes already drilled in cover No. 2. Care should be taken, as shown at *J*, to drill hole No. 1 when the knob is at *a*; hole No. 2 when the knob is at *b*, and hole No. 3 when the knob is at *c*.

Place the wooden box in the indexing head chuck, and true it up as at *K*. Put on cover No. 2 and locate for boring the holes in the box. Then remove the cover and bore the 20 holes in each circle with the proper drill. Either extra long drills can be used or the drills can be pieced to get the correct depth.

After drilling, the box is placed on an arbor as before and finished to size, shellacked, and polished. The bottom disk, No. 4, is then screwed on. The assembly of the knob is shown in detail at *L*, Fig. 2.



A commercial drill box working on the same principle and patented by the Morse Twist Drill and Machine Co., through the courtesy of which firm any reader may make the drill box described above for his personal use

"FROM Machine Shop Apprentice to Production Engineer," and "Building a Jobbing Business" are two remarkable machine shop stories scheduled for early publication in the Better Shop Methods Department. On the schedule are also articles of real dollars and cents value by such experts as Joe V. Romig, Henry S. Laraby, George A. Luers, John Aures, W. Schaphorst, and B. R. Wicks.

Toolmaker Quadruples Pay

As a message of inspiration to mechanics, this article has rarely been equalled. It is a true story and one of the many excellent contributions to POPULAR SCIENCE MONTHLY'S contest, "How I Got that Better Job." The writer asked, however, that his name be withheld from publication.—THE EDITOR.

DURING 1906 I was working as a toolmaker in a shop in New York state at the highest rate of wages then paid for that class of work. I was 28 years old and married.

On considering my situation carefully, I concluded that I had advanced about as far as I could ever expect to go if I continued to depend on my manual skill alone. It was evident to me that I needed more education and since the only way for me to obtain it was to study at home, I took up a mechanical course with a correspondence school.

"We are going to organize a planning room and shall need a foreman——"

I studied for about two years, and while what I learned was of assistance to me in my work in many ways, I was no better off financially. It seemed that I could not get a better job because no opportunity offered for me to demonstrate my ability to fill one.

My opportunity came in a very unexpected manner. The concern I was working for took a contract to furnish some special machines and deliver 500 in two weeks. I was told that since work was slack in the toolroom, it was desirable to transfer a few toolmakers to production work to get the job out on time and was asked if I would be willing to be one of them. I agreed readily and was assigned a job of drilling and tapping 3/8-in. blind holes in a cylinder.

This work was being done on a three-spindle drill, one spindle fitted with the tap size drill, one with the body size drill for counterboring about 1/16-in. deep, the other with a friction drive tapping attachment. I was told that the regular output was eight cylinders an hour, and asked to better it if I could. The material was cast iron, and the tapping operation was slow, since it was required to have a full thread clear to the bottom of a hole 1/8 in. deep. The chips gave considerable trouble and made it necessary to back out the tap and clean out the hole three times for each hole.

Speeds Up the Tapping

I started in with a dry tap, finishing each hole as I went and blowing out the chips with a small tube. In this manner I was able to do five an hour. Then I tried finishing all of the drilling on a cylinder, shaking out the chips, and running the tap into each hole as far as it would go, then shaking out the chips and running it in again until the tap had been in each hole three times and the cylinder completed. In this way I reached the required output of eight an hour. I learned afterward that this was the method followed by the regular operator.

At that time I was studying hydraulics in my course, and naturally the subject was more or less in my mind. I considered what would happen if those holes were filled with liquid and the tap run into the hole. I concluded that the fluid would have to come out of the hole by way of the flutes alongside the tap; also that the more rapid the tap was driven in, the faster the fluid would have to flow out.

I filled one of the holes with oil and started the tap into it, with the result that it went clear to the bottom without the friction slipping. Then I speeded up the tapping spindle, as the oil would keep the tap cool. After doing the drilling and shaking out the chips, I filled all the holes with oil and tapped them out. In this manner I got out 15 cylinders an hour and the second day was able to reach an output of 16 cylinders an hour.

The job was one of considerable importance and the superintendent was giving it his personal attention. The third day he came to me and said, "Bill, they tell me that you just doubled the output on this operation yesterday and I want to know how you did it."

"Well, sir," I replied, "blind holes are always rather troublesome to tap because of the difficulty in removing the chips. I seem to have overcome that by filling the holes with oil first, then, by running the tap in rapidly, the oil is displaced so quickly that it flows up the sides of the tap with sufficient force to carry the chips with it."

I demonstrated it to him, adding, "Of course, you will have to add about a quart of oil a day to the cost of the job!"

I Grasp My Chance

He said, "That is negligible. With oil at 40 cents it would be economy if you used five gallons. How did you come to think of it?"

Here was my chance, and I grasped it. I replied, "Well, you see I have been studying mechanics with the Blank Correspondence Schools for the past two years and just now I am studying the paper on hydraulics. This tapping problem appeared to me a simple matter of displacement."

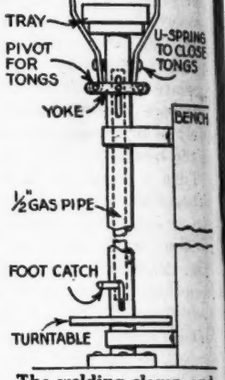
"Simple enough," he replied, and walked away.

In a couple of weeks, when I was back on my old job, a messenger told me I was wanted in the superintendent's office, and on presenting myself, I was told that the firm was going to systematize somewhat and that they needed some one to help organize a planning room. I was asked if I would care to go to a certain concern in the East and absorb what I could of their methods during a period of a month or so, then return and help with the installation of the system. I agreed and in about three months was given the title of "planning room foreman," a position I held for about five years. Then I had an offer from the concern with which I am now connected. My present salary is more than four times what my wages were at the time I started studying.

Foot Operated Turntable Saves Time in Welding

TO SIMPLIFY the work of welding caps on cylinders of about 4-in. diameter, an acetylene welder built the simple rotating clamp illustrated. With slight modifications the same clamp can be used for other similar jobs.

It consists of a piece of 3/4-in. pipe about 30 in. long, with two slots 3/8 in. wide and 2 in. long cut through about 6 in. from each end. The lower slot has an L at the top to act as a catch for a clamp rod. A 6-in. iron disk welded on the pipe 3 in. from the lower end serves as a foot-rest and allows the operator to turn the standard with his foot.



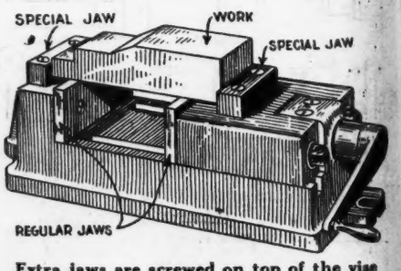
The welding clamp, and diagram showing its construction

A 3/8-in. clamp rod is slipped inside the pipe and drilled to receive the center screw of the yoke for the tongs. The tongs are closed by a U-spring and opened by an upward motion of the rod within the pipe, which wedges them against the 4 1/2-in. tray. If the pins at the bottom of the rod are slipped into the L catch, the tongs are held open without further effort.

A rope and pulley attachment with a counterbalancing weight support the torch without fatigue to the welder.—EDWIN M. LOVE, Alhambra, Calif.

Extending Capacity of a Vise

FINDING it necessary in an emergency to extend the capacity of a vise, I mounted two extra jaws as shown and let the work rest on the regular jaws. This



Extra jaws are screwed on top of the vise

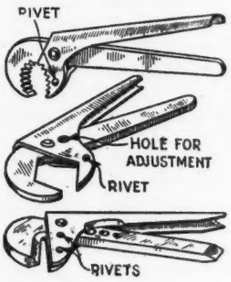
permitted work to be held that was from 1 1/2 to 2 in. larger than the original capacity of the vise. The extra blocks should be at least 3/8 in. thick or, better still, from 1/2 to 5/8 in., to make certain that the work will be firmly gripped.

This idea is a useful one for home mechanics, who often find the small range of their vise a drawback.—J. H. MOORE.

BETTER SHOP METHODS

Simple Plier Type Wrenches Made from Steel Plate

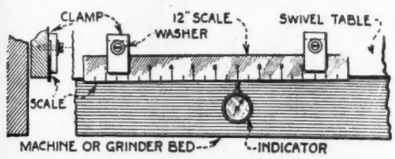
FOR special purposes it is sometimes necessary for a mechanic to improvise a wrench. This is not particularly difficult to do if facilities are at hand for shearing and bending steel plate.



The tools illustrated are made of ¼-in. steel plate sheared to the required shape. One section is then doubled over, riveted, and provided with a pivot pin. The parts must, of course, be properly tempered.—G. A.

Setting Tapers Accurately

SETTING tapers on a grinder, lathe, or milling machine by means of the graduations on the machine itself is usually considered an unsatisfactory method for obtaining accurate results. It makes it necessary to fit and try work when the allowance is small. The simple device illustrated, however, makes considerable accuracy possible with much less difficulty.

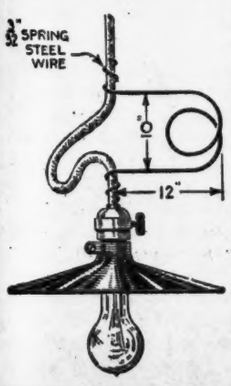


A scale clamped to the swivel table makes it possible to cut or grind tapers accurately and quickly

A piece of work is chucked in the machine and finished off perfectly parallel for its entire length. The scale is then adjusted by means of an indicator so that it is parallel with the work and is clamped in position. After that, the swivel table or carriage is shifted as many thousandths of an inch as is necessary to obtain the required taper. The graduations on the scale allow the depths of large cuts and grinds to be measured accurately.—H. S.

Spring Protects Nitrogen Bulbs

ALTHOUGH nitrogen-filled electric lights of from 100 to 200 watts meet a long-felt need for better lighting in the shop, we found in our shop that the vibration made by cranes and heavy machinery frequently caused the filaments to break, even when the bulbs were suspended on heavily braided lampcords. Because of this, cheaper lights often are still used.



Rather than discard these highly efficient lamps, we made various experiments and finally adopted the shock-absorbing spring shown, which proves satisfactory.—C. J.

10-Day Tube Free

What Men Use

To get those glistening teeth

Note how many men and women show white teeth nowadays.

They are proud to show them when they smile—because they are attractive.

There is a new way of teeth cleaning which millions now employ. It means whiter, safer, cleaner teeth.

Men who want good teeth should use it. Make this free test and see just what it does.

It removes film

You can feel on your teeth a viscous film. It clings to teeth, gets between the teeth and stays. Food stains, etc., discolor it. Then it forms dingy coats. Tartar is based on film.

That's why teeth look cloudy.

Film also holds food substance which ferments and forms acids. It holds the acids in contact with the teeth to cause decay. Germs breed by millions in it, and they cause many troubles.

That's how teeth are ruined.

Avoid Harmful Grit

Pepsodent curdles the film and removes it without harmful scouring. Its polishing agent is far softer than enamel. Never use a film combatant which contains harsh grit.

You must do this

Old ways of brushing do not end that film. Some always remains to threaten serious damage night and day.

So dental science sought a film combatant, and two methods were discovered. One acts to curdle film, one to remove it.

Experts proved those ways effective. Then dentists everywhere began to advise their use.

A new-type tooth paste was created, based on modern research. The name is Pepsodent. Those two great film combatants were embodied in it, for daily application.

Now careful people of some fifty nations use this new way to clean teeth.

Fights acid too

Pepsodent also multiplies the alkalinity of the saliva. That is there to neutralize mouth acids, the cause of tooth decay.

Pepsodent multiplies the starch digestant in the saliva. That is there to digest starch deposits on teeth which may otherwise ferment and form acids.

Those are Nature's great tooth-protecting agents in the mouth. Every use of Pepsodent gives them manifold effect.

The new-day way

Pepsodent is the tooth paste of today. Millions already use it. All careful people will adopt it when they know its benefits.

Send the coupon for a 10-Day Tube. Note how clean the teeth feel after using. Mark the absence of the viscous film. See how teeth whiten as the film-coats disappear.

Then you will realize what this method means to you, now and in the future. Cut out the coupon now.

Pepsodent PAT. OFF. REG. U.S.

The New-Day Dentifrice

A scientific film combatant, which whitens, cleans and protects the teeth without the use of harmful grit. Now advised by leading dentists the world over.

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THE Sargent Auto-Set Bench Plane will mean a great saving of time and trouble at your work-bench. For whenever you have to remove the cutter, you can replace it at the same adjustment you were using and go on with your work.

The cutter of chromium alloy steel keeps its edge an unusually long time. And always makes shavings—even when cutting across the grain or through tough, knotty wood. The cutter is so rigid it will never chatter.

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Write for the Sargent Book of Planes. It is full of detailed information on these fine tools and many other styles of superior planes.

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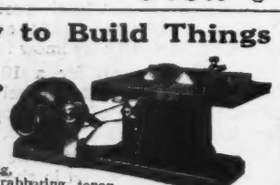
It's Easy to Build Things with a Junior Bench Saw



Does your ripping, mitering, grooving, rabbeting, tenoning, sanding, grinding and many other operations with surprising ease and accuracy. Top 10" x 13". Saws 1 ¼" stock. Dadoes ⅛" x ¾". Machine built entirely of metal. Driven by ¼ or 1/3 h. p. motor. Portable. Attaches to any light socket. Extremely accurate.

Descriptive circular tells many things of interest to workers in wood and soft metals.

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BETTER SHOP METHODS

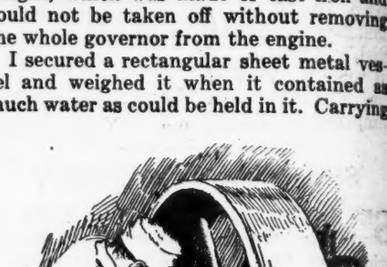
Solving Weighing Problems by Water Displacement Method

By W. F. Schaphorst

NOT infrequently it is desired to know the weight of some part or other on a machine that cannot be detached easily for weighing and is too irregular to be computed quickly. In such a case the weight can be found indirectly by weighing the water displaced by the part, if the part projects in such a way that it can be made to displace water.

The writer, for example, once had to determine the weight of a flywheel governor weight, which was made of cast iron and could not be taken off without removing the whole governor from the engine.

I secured a rectangular sheet metal vessel and weighed it when it contained as much water as could be held in it. Carrying it to the engine, I raised it until the water level cut the governor arm.



Displaced water serves as index of weight and cubic contents

Next, I removed the vessel and again weighed it, this time with the remaining water. The weight of the governor end was then computed in this manner:

The first weight was 45.5 pounds and the second weight was 39.25 pounds. The weight of the water displaced was, therefore, 45.5—39.25 = 6.25 pounds.

To compute the weight of the cast iron that displaced the water, all that was necessary was to multiply by the specific gravity of cast iron, which is 7.207, or 6.25 x 7.207 = 45 pounds.

The remainder of the arm was of regular cross section, the weight of which was very easy to compute on the basis of 0.26 lb. per cu. in., the weight of cast iron.

In case other metal parts are to be weighed in this manner, here are the specific gravities of common metals as I use them, although tables vary somewhat:

Cast iron	7.207
Wrought iron	7.78
Soft steel	7.833
Steel castings	7.917
Cast aluminum	2.60

Should it be desired to find the volume of the piece of metal in cubic inches, divide the difference in weight (which is equal to the weight of the displaced water) by .0362. The result is the volume of the part in cubic inches.

This latter test will come in handy for finding the volume of any irregular substance that can be submerged in water without harm or without any absorption of water. Or, should one wish to find the specific gravity of coal, brick, rock, etc., reversing this method will serve.—*(Copyright, 1923, by W. F. Schaphorst.)*

The Circus—A Mechanical Wonder Show

(*Continued from page 23*)

appliances. Soon you will see these fans not only in the circus but in theaters, hotels, and other public places.

All the activities I have described in putting up a show take place almost simultaneously, so that within three hours after we reach a lot, the show is ready for business.

Back in 1914 we were late in getting to the lot in Dyersburg, Tenn. We had less then 2½ hours to get ready. Jimmy Whalen, our boss canvasman, put the show up in two hours and 10 minutes. I believe that is a record even for Whalen, who has been putting up shows for us for more than 40 years.

Taking down the show requires an equal amount of mechanical ingenuity. Everything is done at once. While the crews with block and fall are letting go the lines, the mechanical stake puller—a lever on wheels—is lifting the stakes. By the time the last person is out of the grandstand, most of the circus is on the way to the trains.

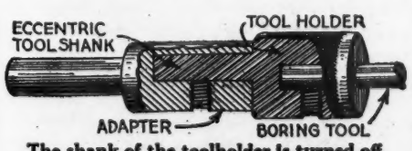
One hundred railroad cars are required to move the modern circus. This railroad equipment is the mechanical outgrowth of the oldtime circus wagon caravan. The boss trainman uses the inclined plane and block and fall to load the circus on the cars. He snakes 14-ton wagons up the incline just as easily as he would a light surrey. A few hours after the show closes, we are on our way to the next town.

And we always get there. We have been in many wrecks, but the mechanical expertness of our train crew always has pulled us out. On one occasion, coming out of Halifax, N. S., we were badly wrecked, but our boss trainman cut the rails on a parallel track, bent them to form a switch into our track, borrowed some equipment from the railroad, and went on his way.

Every one connected with the show knows something about machines. There aren't many industrial corporations that can boast of better mechanics. And that is one reason why the circus is a growing American institution, appealing to the fun-loving public year after year.

Simple Boring Tool Holder

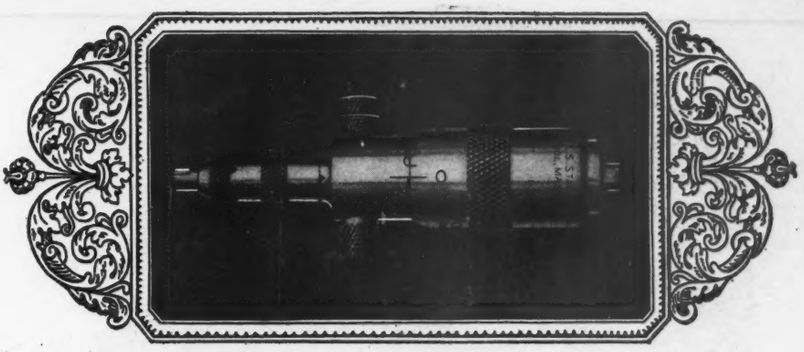
THIS adjustable boring toolholder is inexpensive and very easily made. The shank of the adapter is held in the milling machine chuck, and the shank of



The shank of the toolholder is turned off center to allow various adjustments of the boring tool

the toolholder proper is turned off center to allow various adjustments of the boring tool. The size of the toolholder is governed by the work it is to be used upon, but the principle of operation remains the same for all sizes.—L. S.

CAST iron can be bent if heated to redness and gradual pressure (not blows) applied.



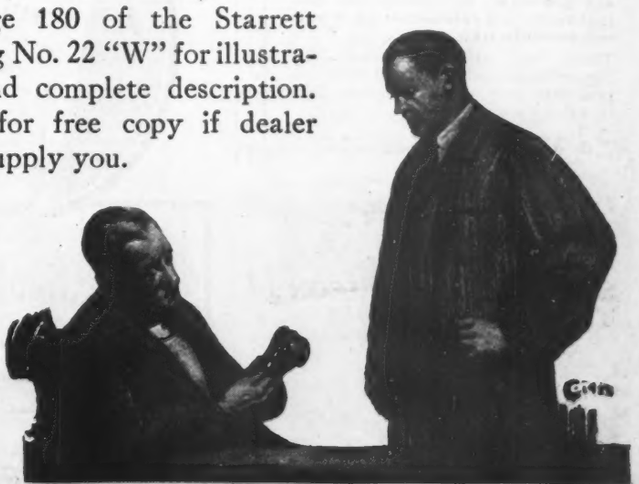
No wonder a man is proud of his Starrett Tools

SOME tools *look* well. Other tools are ingeniously designed—they're handy to use. And still others are built unusually well—they're good for a lifetime's use.

Starrett Tools combine *all* these features—convenience, finish and workmanship. And in addition they're the most *accurate* precision tools made. That's why a good machinist says "Starrett" when he's adding to his tool kit.

THE L. S. STARRETT CO.
The World's Greatest Toolmakers
Manufacturers of Hacksaws Unexcelled
ATHOL, MASS.

The Micrometer Head illustrated above is part of our Inside Micrometer Set No. 124. A splendid "mike" which is furnished in four size combinations ranging from Set A (2 to 8 inches) to Set D (2 to 32 inches). Turn to Page 180 of the Starrett Catalog No. 22 "W" for illustration and complete description. Write for free copy if dealer can't supply you.



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Use Starrett Tools

Have You a Precision Tool Kit?

Every Mechanic whose tool kit is complete with Brown & Sharpe Tools, is well prepared to do the close limit jobs that come up every day—he has a *precision* tool kit.

Brown & Sharpe Tools help him do the difficult jobs well—they have helped mechanics do accurate work for over 70 years.

Write for a No. 28 Small Tool Catalog and select the tools that will build up your kit for greater precision.

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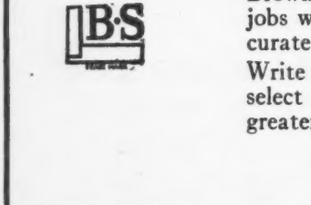
BROWN & SHARPE TOOLS



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are preferred by ladies—the adjustment rod telescopes so it will not catch in hair or net.

There are other reasons why Stromberg-Carlson Head Sets are preferred not only by ladies but by all critical users—

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The receivers are balanced as to volume—both ears get the message.

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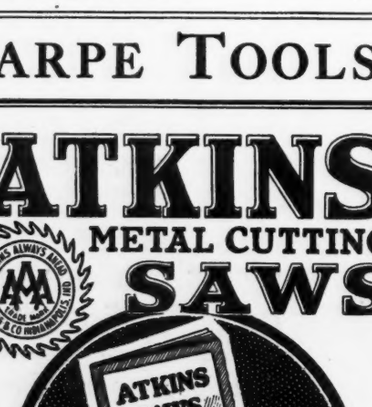

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This book is based on the experience of practical saw makers and users. It is valuable to every man who uses or buys saws for cutting metal. Send for it NOW.

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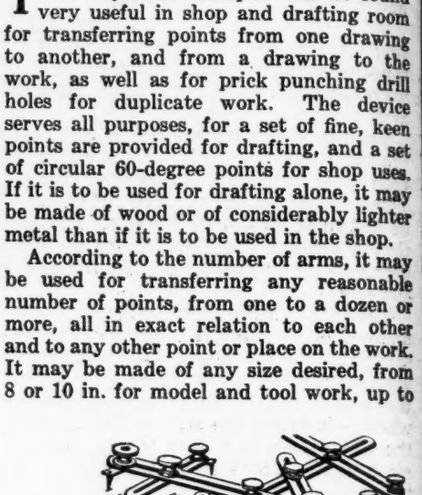
BETTER SHOP METHODS

Transferring Templet Saves Time for Draftsmen and Machinists

By Charles A. Pease

THIS adjustable templet will be found very useful in shop and drafting room for transferring points from one drawing to another, and from a drawing to the work, as well as for prick punching drill holes for duplicate work. The device serves all purposes, for a set of fine, keen points are provided for drafting, and a set of circular 60-degree points for shop uses. If it is to be used for drafting alone, it may be made of wood or of considerably lighter metal than if it is to be used in the shop.

According to the number of arms, it may be used for transferring any reasonable number of points, from one to a dozen or more, all in exact relation to each other and to any other point or place on the work. It may be made of any size desired, from 8 or 10 in. for model and tool work, up to



Made up of interchangeable parts, this templet is used for transferring a layout accurately from one piece of work to another

several feet for large machine work; and within any ordinary range of sizes, all arms are interchangeable. The shorter arms used by themselves form a small instrument.

The size I have found the most satisfactory for my own work is light enough for convenience on the drafting board and yet stiff enough for accuracy up to 24 or 30 in. and, when using the shorter bars, rigid enough for offsetting and prick punching on metal up to 12 or 15 in.

The bars are steel, iron, or spring brass. "Half spring" brass will work the easiest, but is not quite as stiff as spring brass. Saw steel is stiffest, but rather hard to work if you have to cut the slots by hand. Mild steel or brass works easier and is stiff enough for any ordinary work. Brass will make the best looking instruments if you keep it in good shape.

The stock should be in strips 1/16 in. thick, corresponding to No. 14 American wire gage, 18 in. long, and ¾ in. wide.

For drafting purposes only strips about No. 16 or 1/20 in. could be used to advantage, and if a little extra thickness is desired, the 18-in. bar may be made of No. 12 stock, 1/12 in. If saw steel is used, the material may be two gages thinner.

A good assortment of bars is one 18 in. long, three each 12, 10, 8, 6 and 3 in.; and two 4½ in. This requires eight 18-in. pieces. Cut a slot down the center of each bar a little less than 3/16 in. wide, to within about ¼ in. of each end, and round the corners and smooth the edges.

Each of the clamping screws for holding

points is made of a No. 8 round head machine screw with a washer soldered to its head, and a milled thumbnut, as shown at *a*.

For each of the points a piece of thin steel or brass of the shape shown at *b*, about ⅜ in. wide and ¾ in. between the centers of the holes, is required. One hole should be large enough to turn freely on the No. 8 clamp screw, and the other, if for drafting points, should be about 3/32 in. If for prick punch points for metal, it should be the same size as the other hole, about 3/16 in. The points should be about ¾ in. long, from point to shoulder.

The drafting points may be of soft steel, 3/16 in. or less in diameter, as shown at *c*, but for prick punching the point should be of tool steel and of the shape shown at *e* or *f*, the angles being from 60 to 90 degrees. The point shown at *e* is for ordinary work, the stock being ¼ in. in diameter and the angle 60 degrees, while that at *f* is a "pump center" for transferring centers from large holes, and may be from ¾ to 1¼ in. in diameter. The points are riveted to the straps, as shown at *d* and *g*. For the pump centers, the piece *b* should be long enough to free the head of the clamp screw.

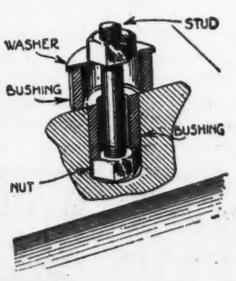
A single gage for transferring from a drawing to metal is shown at *h* and *i*. A long gage for similar use, with two clamp screws, is shown at *k*. Flat gages, long and short, for use on the drafting board, are shown at *l* and *m*.

In use the gages are set to bring the main bar in a convenient position relative to the work. The points on the various arms are then adjusted as desired and clamped in place. Two or more points may often be located on the same bar. Where two points or holes are already in a fixed position to which others must bear a certain relation, the first two needles or punch points are set to them and the use of the outside gages is not required. When all the punches are set, the whole device is transferred to the blank, and the gages being brought to the edges, each punch is tapped or pressed to transfer the point accurately to the new work.

The addition of a 24-in. bar, made from stock about 3/32 in. thick, will increase the capacity of the instrument, especially for heavier and larger work.

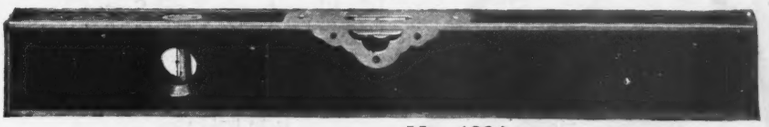
Removing Blind Bushings

FOR jigs or machine parts, where it is necessary to use blind bushings that are to be renewed when worn, one way to provide for the easy removal of the bushings is as follows:



The hole for the bushing is drilled deep enough to permit a nut to be placed in it before the bushing is put in. Then, to remove the bushing, a stud is screwed into the nut, another larger bushing is placed over the hole and a washer and nut provide the means of drawing up the bushing.—G.P.

IN FIGURING the capacity in gallons of a tank, change all the dimensions into inches, square the diameter, multiply by the length and then multiply by .0034.



Brass Bound Mahogany Level, No. 1224 Price, $7.70

To lift your work out of the "amateur" class

THAT'S what this Goodell-Pratt Level is for. Instead of finding yourself a half or a quarter of an inch out of the way when the job is finished, you'll find the job plumbs up true all ways. And that's real satisfaction.

Made of five pieces of thoroughly seasoned mahogany, with brass binding rods dovetailed the entire length and doweled to heavy brass end plates. Side views protected by brass plates.

The vial is accurately ground on the inside and is extremely sensitive. Set solid in the stock, as a double moveable bar adjustment is used. Plumb glass has a similar adjustment.

Size, 24 x 3 x 1¼ inches.

Mr. Punch says:
"The difference between working with and working without one of these levels is the difference between guessing you're right and knowing you're right."

Other tools you need

In the Goodell-Pratt line of 1500 Good Tools are many that should be on your work-bench now. Each tool is made with the care and skill that only the best toolsmiths can give to it.

Write for a copy of the Goodell-Pratt Catalog No. 15. It pictures and describes all the tools in which you are interested. The book is free.

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GOODELL-PRATT
1500 GOOD TOOLS

The Business End of a Bit -

WHEN a bit bores its way thru wood, the important part of the operation is performed by what is called the cutting-head. And this cutting head is made up of several parts, all of which must work together in perfect unison if the boring is to be easy.

The screw (1) pulls the bit into the wood while the spurs (2) cut off the edge of the chips and the cutters (3) scoop them up and pour them into the roomy throat (4) through which they are carried out of the hole by means of the twist of the bit.

It is the perfect working-together of these parts which so distinctively marks the easy boring of IRWIN Bits at which thousands of men have marveled. The reason is found in the design and finish of the business end of Irwin Bits and Augers.

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THE I.A.B.CO.
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BETTER SHOP METHODS

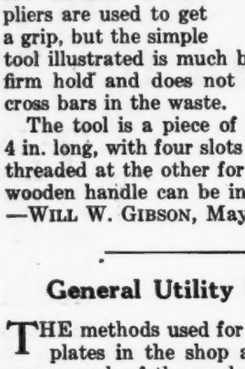
Plumber's Tool Saves Time in Tightening Washbowl Waste

EVERY plumber knows how awkward it is to hold the waste while tightening it in a bowl or bathtub. Generally the handles of the pliers are used to get a grip, but the simple tool illustrated is much better. It gives a firm hold and does not mar or bend the cross bars in the waste.

The tool is a piece of ½-in. pipe about 4 in. long, with four slots at one end. It is threaded at the other for a tee, in which a wooden handle can be inserted, if desired. —WILL W. GIBSON, Maysville, Ky.

General Utility Plate Pins

THE methods used for fastening parts to plates in the shop are important, because much of the work must be clamped down for laying out, drilling, assembling, grinding, boring, and other machine operations. For such fastenings the type of plate pin illustrated is handy because of its adaptability and simplicity.

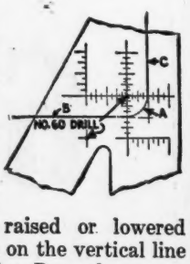


The body is cylindrical with a square head through which is a tapped hole for a pointed setscrew. The shank is seated in any drilled hole of its approximate diameter in the plate adjacent to the casting or part to be fastened, and the set screw is turned against the work or filler blocks. The canting of the shank in the hole prevents it from being lifted upward.—G. A. LUERS.

Drawing Rounds and Fillets

TO SAVE time in locating centers for radii in making mechanical drawings, I scratched the scales illustrated on one of my transparent triangles. This simplifies considerably the drawing of fillets and rounded edges, which occur so frequently in mechanical drafting.

For instance, if it is necessary to locate the center for a ½-in. fillet, *A*, to be drawn so as to connect the lines *B* and *C*, the triangle is run along the T-square until the ½-in. division on one of the horizontal lines rests exactly over the line *C*, and the T-square and triangle together are raised or lowered until the ½-in. division on the vertical line rests exactly over the line *B*, as shown.



A needle point or sharp pencil is then pressed through the small hole to mark the center of the fillet. The point of the bow compass is then placed on the center as marked and the radius swung off directly between the lines. The operation is much quicker to do, of course, than to describe. —R. W. ADAMS, New Britain, Conn.

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See page 4 in front of book for full details

Gypsying de Luxe by Auto

(*Continued from page 70*)

gasoline stove and refrigerator. In addition, the equipment includes lockers, electric lights, screened windows front and rear, and a real screen door at the rear. The weight of the entire outfit is 950 pounds.

A trailer, incidentally, offers few driving difficulties. It follows in the tracks of the car almost perfectly. The advantages of the folding trailer bungalow are that it affords additional comfort, saves time in making and breaking camp, and leaves the car free from the clutter of camping equipment.

Don't Take Chances on Roads

To insure against any possibility of accident that might spoil the entire trip, it is well to guard against taking chances of any kind. When exploring strange roads, beware of mud, especially muddy mountain roads. Wet clay is especially slippery. Sand and loose gravel should be negotiated carefully.

Drive slowly along narrow roads and always keep the car well under control when descending a hill. If a hill is steep enough to demand low gear in ascending it, use low gear in descending it. The same rule holds for second and high gears. In descending long hills, use the engine as a brake, with the gear lever in second or low, to prevent burning of the brake lining. Keep well within the written and unwritten laws of the road; be alert continually, and you will not be likely to meet with a mishap.

Many trips have been spoiled by failure to investigate an unusual noise while the car is in motion. On the other hand, it is a mistake to be too keenly on the alert for strange noises. The clatter of something dropping from the car is worth investigating. By doing this, important parts of the car or accessories, such as spare tires, license tags, and bolts may be recovered.

If it is planned to carry a heavy load of equipment—say 1000 pounds or more—it is advisable, although not absolutely necessary, to add stiffening leaves to the rear springs. You can overload a well built touring car a thousand pounds without breaking the springs, provided you take the bumps carefully. But it is safest to take the car to a spring maker and have extra leaves put in. The cost should not be more than $15 or $20.

Carry Only What You Need

A final warning—don't try to take along a lot of extra paraphernalia that you think you "may need." The chances are 10 to one that you never will use it and that it will only kick around in the way. Take just what you are *sure* you will need for comfort and convenience, and let it go at that.

Be sure to take plenty of warm clothing. Flannel shirts, and khaki breeches are most serviceable for both men and women. Each member of the party should have a sweater and a raincoat. Remember that on the comfort and health of each person depends the enjoyment and success of the entire auto-camping trip.

Next month—Another helpful article by Mr. Blanchard: How to Clean the Car and Keep It Looking like New. Practical hints for the automobile owner.

The Receiver of Tomorrow

The Symphony

Tomorrow in Radio means a wider and more useful as well as more entertaining broadcasting. Therefore, to the purchasers of receiving sets, the design, the material, the workmanship, the circuit and the assembly, all play an important part in the quality of reception, and distance heard.

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The clear reception and unusual volume are the results of the high grade units, the fine workmanship, the most efficient circuit, and the correct assembly. The improved circuit used in the Symphony combined with the accuracy of its construction, has increased the selectivity to a marked degree.

The range of the Symphony Receiver is unlimited. Recently, in Chicago, Havana, Cuba, was tuned in not only on a head set but heard plainly on a loud speaker.

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George Buss,

of Elizabeth, N. J., knows a good tool when he sees it!

Here is what he wrote us recently:

"I HAVE a Millers Falls brace which I have used for 15 years. I have bored through 6" yellow pine with a 1¼" bit, and the brace is as good as when I bought it. I have been working at the carpenters' business for 56 years and know a good tool when I see it."

TODAY we know even more about making braces than we did when we made the one that George Buss bought. If you want a brace that will last you fifteen or twenty years, and bore through yellow pine, and some things even harder than yellow pine, you can't do better than say "Millers Falls" to the man behind the counter.

Millers Falls Ratchet Brace No. 732—one of our better grade braces, and a great favorite with carpenters, mechanics and men who like to work around the house.

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MILLERS FALLS TOOLS SINCE 1868

THE HOME WORKSHOP

New Motorboats from Old

by Capt. E. Armitage McCann

Third and last of Captain McCann's series of articles on motorboat repairing

OUR old but sound motorboat is now repaired and remodeled at stem and stern and recalked throughout. It now remains only to make good the decks and interior and prepare for installing the engines.

The skin or lining, and certainly the floorboards, should be removed as far as possible. The inside of the hull is then thoroughly cleaned with strong soda, followed by plenty of water. All grease and dirt must be scraped out of the limbers and the limber holes made clear, so that any water taken aboard will run to the lowest point for bailing or pumping.

Rebuilt, shipshape, and ready for the first cruise

Should any of the ribs be shaken, broken, or split, new ones should be placed alongside them. Oak is perhaps the best for this, although a more flexible wood is easier to work. They will probably require steaming for an hour in your steam box or boiling for half an hour. If a thin strip of iron is clamped on the outside of them, they can be bent readily to shape on such a board as shown in Fig. 2. The pattern should first be chalked on the board and the rib bent a little more than required for its final shape.

The heart of a motorboat is its engine, so perhaps the next thing to do will be to prepare a bed for it. This must be very firm and so placed and fixed that the strain and stress will be distributed over as much of the boat as possible, the weight being transmitted to the keel. Fig. 3 shows two common types of engine bed, but here one will have to be guided both as to build and position by the kind of motor to be used. Directions for the bed are given, as a rule, with the engine specifications, but it is better to have the engine beside you before laying the bed, even if you remove it again until required.

As a general principle, a piece of tubing or a string passing up the center of the shaft hole from the stern will give the correct position. It must meet the shaft of the engine and be at the same angle.

If the rudder needs replacing or renewing, it may be either of wood or iron. If wood, it should be of about 1½-in. oak or of a thickness to fit the pintles, and slightly tapered toward the stern. The hardware for it (pintles and gudgeons, Fig. 4) can be bought ready made.

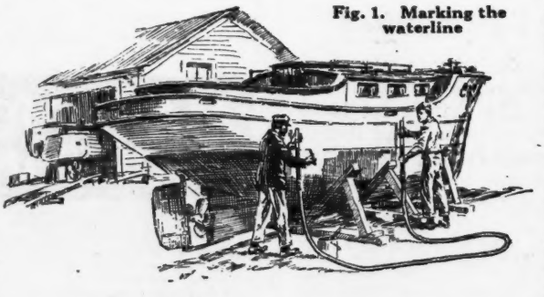
If an iron rudder is required, it had better be bought complete, but can be made by splitting the lower end of a rudder post to take the blade, which is riveted to it. The simplest form of a rudder trunk is a piece of gaspipe large enough to take the rudder post or fill the existing hole. It must be made watertight with wooden stuffing boxes.

The rudder post may extend above the deck or may stop short of it. In the former case, the steering can be done by a simple tiller, extending forward; but ordinarily a quadrant is used, with wheel ropes extending to the barrel of the wheel. These may be of cord, but light phosphor-bronze ropes are the best.

The neater arrangement is to have the quadrant under the deck, if there is room, but a good plan is to have the quadrant under deck and the rudder post extending above, with a square end and a nut, so that an emergency tiller can be quickly shipped in case the gear breaks down. Figure 5 shows wheel plans. A side wheel takes less room, but is not so convenient for steering as a central wheel.

While this work is going on, the inside of the boat should receive two coats of good paint. The lining and deck planks may now be replaced, making sure that the latter can be lifted easily as occasion requires.

Fig. 1. Marking the waterline



If there is no deck, it is strongly recommended to put one in, even if it is only a small piece in the bow and stern and a foot or so at the sides, as you have then a much better sea boat and a more comfortable vessel.

Presuming there is already a deck, as is usually the case, but that it is badly scratched, marked, and leaky, the best plan will be to scrape it smooth, fill in the worst hollows with putty and cover it with canvas, laying this down on a heavy coat of wet paint, and tacking it securely with

copper tacks. It should go under the covering boards at the sides and the molding round the house in the middle, if any. Then it should receive at least two coats of paint. Damping the canvas before the first coat will give a better surface and save much paint.

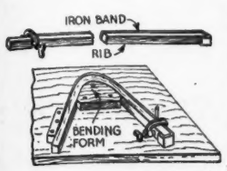


Fig. 2. How to bend ribs

If the deck already is covered with canvas, the paint may be smoothed with paint remover or even burned off and recoated, but if it is patched or torn, it will have to be ripped off. Figure 6 shows how the deck is laid.

It is well to keep some marine glue handy. By its judicious use, many a leaky place can be made watertight without joinery, sometimes by filling a crack with it, and others by gluing a piece of canvas over the part, provided the damaged part is not one affecting the strength of the boat.

Although some boats do not have a cabin, even a small one is very handy, especially when bad weather or rain is encountered. On the other hand, too much open space should not be sacrificed for this, as there is no joy in motorboating in fine weather in any kind of cabin, no matter how roomy or luxurious. It is better to take a chance with the rain.

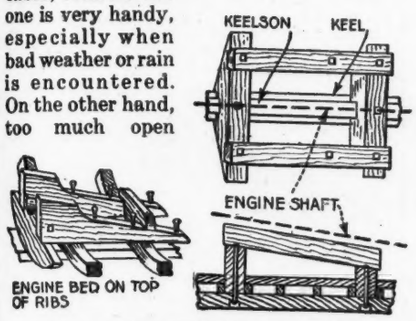


Fig. 3. Two methods of preparing the engine bed

Suppose there is a little cabin, open at the after end into the cockpit or stern sheets. If it is of solid construction, with portholes or small windows, it is a good plan to cover it with light canvas or duck, and paint it. The top is best treated in this way in any case, but if it is mostly windows, as is usual on the smaller boats, all the old paint or varnish must be removed, the bad places neatly repaired or renewed, and the whole given two coats of good varnish.

A good plan inside is to have a seat or settee along each side, built in, so that there are lockers underneath, with a table down the center, for preference so built that it can be pushed up out of the way. If room can be spared, it is a great convenience to partition off a couple of feet in the fore end for toilet facilities. If there is still room left, a little galley can be arranged alongside this, with some form of oil or gasoline stove so fixed that it will not upset in a seaway.

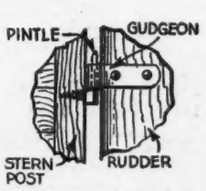
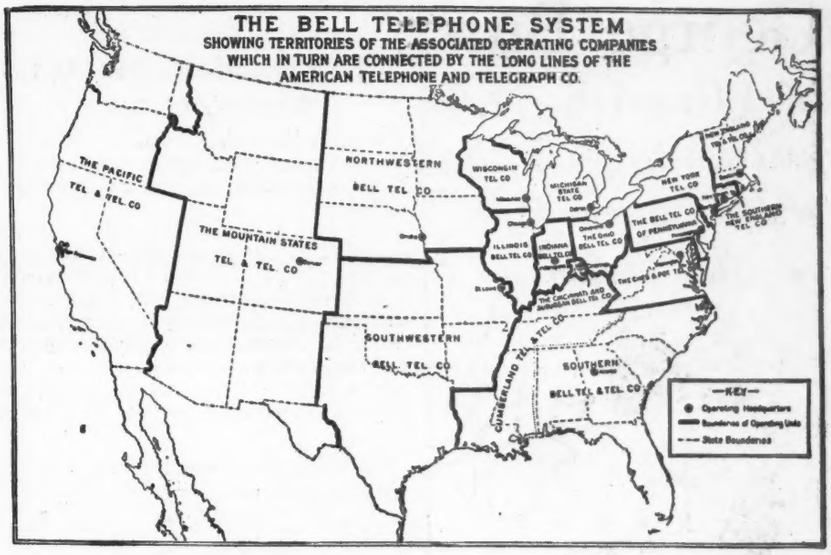


Fig. 4. Rudder detail

A small overhang at the after end of the cabin roof helps to keep the rain from blowing into the cabin. Along the top of

(*Turn to page 90*)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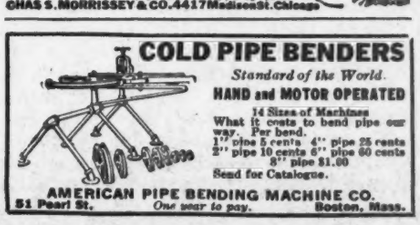
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This lever controls the two speeds. Change instantly without removing drill from work
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"YANKEE" TOOLS

Make Better Mechanics

THE HOME WORKSHOP

New Motorboats from Old

(*Continued from page 89*)

the cabin there should be a grab rail of wood or brass. Cushions, curtains, and the like should be selected, both for appearance and wear.

The arrangement of the cockpit will be governed largely by the position and area of the engine, but the usual plan is to have a seat right around it, with removable cushions. The lining may be either varnish or paint. Arrangements may be made to erect an awning over the cockpit.

The outside of the hull has yet to be painted. It should have three thin coats,

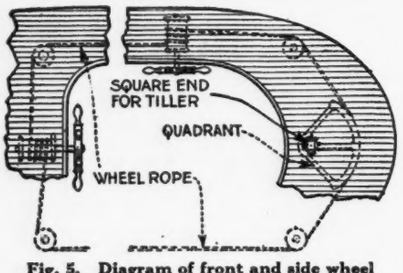


Fig. 5. Diagram of front and side wheel arrangements for steering, the former being the more convenient

applied in dry weather on a clean surface, otherwise you will be troubled with blisters.

The most difficult part of this operation is cutting the waterline. If the boat has been previously painted, before removing the paint, mark the waterline height at the stem and stern. Then if you have a level floor to work on, wedge the boat up so that it is dead upright and the same height from the floor at both ends, the line can then be marked with a stick of the right length, across the top of which a piece of chalk is laid. Unfortunately we cannot usually find this level floor. If one can find a couple of helpers, it may be done with a chalk line, but even with this guide it is no easy matter, as the boat curves in at the ends, and the string will not do this without getting out of level.

An easy method is to get a piece of tubing, to insert a piece of gage glass or other glass tube in each end, fill this with colored or muddy water, fix or have some one hold one tube to one of the marks, and see that the water is up to this level. The water at the other end will always be at the same level and you can mark from it. The actual painting is best done with a long, flexible straight edge and a painter's lining fitch. The underwater portion should be painted with some good copper paint and the upper to please your own taste.

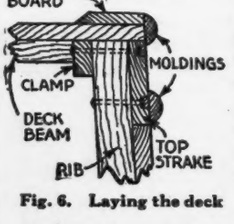
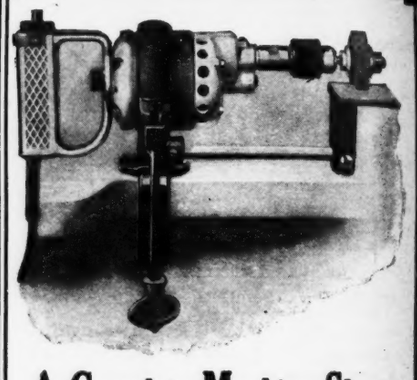


Fig. 6. Laying the deck

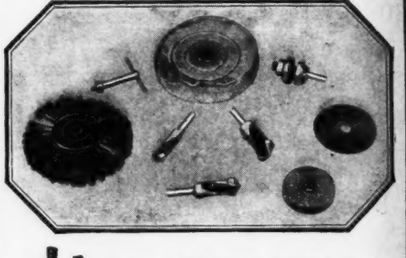
A signalling mast is an improvement and not a difficult thing to make. It may either be stepped on the fore deck or on the cabin top, the former being the better if practical. It is as well to have light wire stays from near the top to each side for carrying your flag and at night the white light. The mast will also support your aerial, if you have a radio set.

Your boat is now ready for the engine and propeller, and such light equipment as is needed. And now for the first cruise!



A Complete Machine Shop In One Tool

The Jones Electric Drill can be clamped to a bench, and by means of the attachments, can be used for **grinding, polishing, buffing, sawing,** or **light milling, counterboring,** etc. It's just the tool for home use—powerful, compact drilling up to ¼" thru steel. This drill is 10" in length, net weight 4 lbs., and is fitted with a No. 1 Jacobs Chuck. It sells for the unusually low price of **$25.00** without attachments. Attachments at slight additional cost. Write today for folder which completely describes this most desirable tool.



We also make the **automatic bench drill press** illustrated at left. It is a remarkable tool for home drilling, selling for only **$45.00.** It is completely described in a folder. Write for it also.

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SPECIALLY 6.95 PRICED

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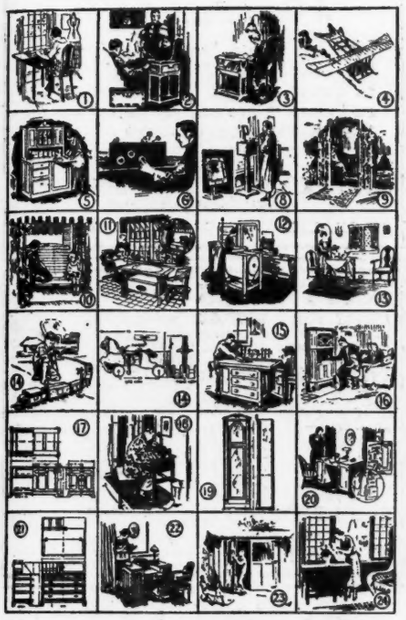
Plans that Simplify Your Home Workshop Problems

A GOOD working drawing and a bill of materials are essential whenever you wish to make anything at all elaborate in your home workshop. They save you time, money, and effort. To try to get along haphazardly without them is to invite failure. No expert mechanic would think of attempting it.

The blueprints in the Home Workshop series are especially intended to help you in this vital matter of planning. Whenever you plan something new, consult the blueprint list, because it contains the best working details of their kind.



Miniatures of previous Home Workshop blueprint projects. See page 75 for this month's subject

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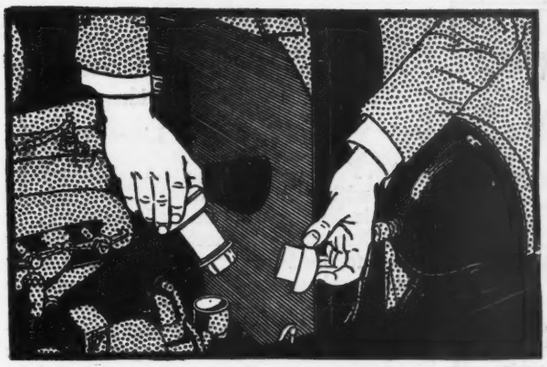

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Now you can try this remarkable new invention on your Ford for 10 days at our expense. Send no money. Simply mail the coupon below

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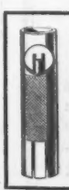

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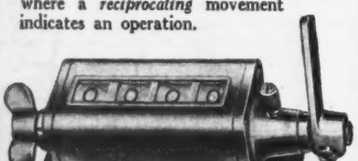
They register on the dial of a Veeder Counter, thru the obvious necessity of the operator making a *good* record; one that justifies good pay.

Work *moves* at the counter-equipped machine as it never moved before, because work and production alone moves the figures of the

Veeder COUNTER

The Set-Back Rotary Ratchet Counter below is for machines such as presses and metal-stamping machines, where a *reciprocating* movement indicates an operation.



Registers one for each throw of the lever, and sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price with four figures, as illustrated, $11.50—subject to discount. (*Cut less than ½ size.*) Set-Back *Revolution* Counter of similar model, $10.00 (list).

The Hand Tally illustrated below is used for counting anything from number of people attending a ball game, to number of packages in an inventory. In the public place it counts *persons;* in the factory or store it counts *stock;* in the "open" it may count anything from cattle on a ranch, to poles on a telephone line!

Registers one for each pressure of the thumb lever: counts up to 10,000, then repeats. Can be set back to zero from any figure by turning knob once round. Size, exclusive of finger ring, 2 inches greatest diameter. Price, $5.00.

Write us about that counting problem of yours—it's probably answered in the new 80-page Veeder Booklet; copy free

The Veeder Mfg. Co.,
44 Sargeant St., Hartford, Conn.

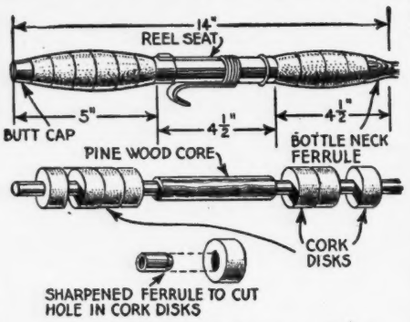
Easily Made Double Handgrasp Improves Bait-Casting Rod

By Robert Page Lincoln

ANY one who has done much casting with a bait rod knows the value of a double handgrasp. In reeling the lure or handling a fish, the left hand instinctively goes forward to grasp the rod, and an extra cork grasp is therefore a desirable addition.

The double handgrasp measures from the butt cap to the bottle neck taper 14 in. The cork disks or washers are trimmed slightly larger than their finished size and holes are cut into them with an old ferrule filed sharp. The cork should be of good grade and free from holes, the pieces being 1 in. thick or less.

The corks are put in place one at a time, after the edges of the holes and the sides of the corks have been coated with rod cement. When the forward grasp is filled,



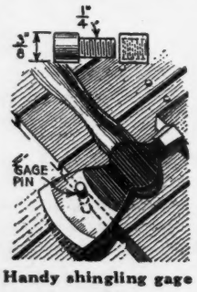
How the double handgrips are built up from sections of cork

make a foundation of pine to slip over the rod for the reel seat. This should be ¼ in. or more shorter than the reel seat, so that the first cork of the forward grasp can be trimmed and worked down into the reel seat. Not a little care is needed in shaping the wooden piece, because it must fit exactly the under side of the reel seat. It is then slipped into place and cemented to the cork.

The reel seat is next put in place; then the corks of the back grasp are put on, and both grasps are trimmed with sandpaper to the correct shape. Three screws are used for fastening the butt cap, two for the reel side, and three for the bottle neck ferrule.

Spacing Gage Fastens Directly to Shingling Hatchet

THE shingling device illustrated, which I made for a carpenter friend, has saved him much time in laying shingles. It consists of a locating pin made in two pieces, as shown, to fit through a hole in the blade of the shingling hatchet. By placing the pin against the edge of the row of shingles already in place, the head of the hatchet gives the location for the row of shingles to be laid above without the necessity of measuring.—J. A.



Handy shingling gage

Stillman Taylor, sporting writer, tells next month how to build a floating camp

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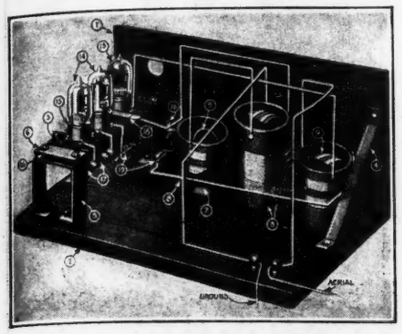

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The blueprint contains working drawings, instructions, and bill of materials of a two-stage regenerative receiving set that a professional would be proud to own. It comprises a variocoupler and an Armstrong two-variometer-regenerative tuning circuit coupled, if desired, with two stages of audio frequency amplification.

The tuning coils have been selected because of the ease with which they may be constructed at home.

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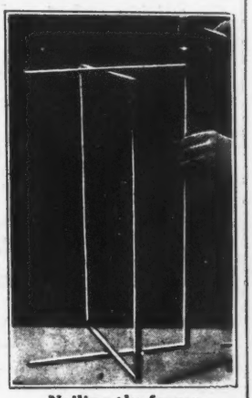
P. S. July

Making a Simple Box Kite and Kite Reel

THIS box kite, which is of Japanese origin, is made in the simplest possible fashion of eight sticks and some cambric or paper. Four of the sticks are 20 in. long and four 12 in., all of them either ¼ in. square, ⅜ in. square, or ¼ by ⅜ in.

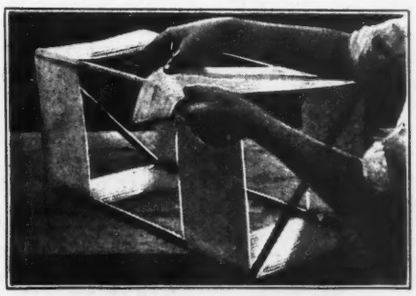
Two crosses are made by nailing the smaller pieces together in pairs with thin brads. It is best to make holes first with a thin drill, brad awl, or hot needle. The crosses are then nailed to the ends of the four long sticks. Considerable care is necessary not to weaken the joints by splitting the wood. String can be used to reinforce the frame, if it appears to be necessary.



Nailing the frame together

Two strips of brightly colored cambric or paper, about 3 ft. long and 5 in. wide, are fastened to the sticks and the ends are glued together. The bellyband can be adjusted by trial; usually the best results are obtained by fastening the upper end about 4½ in. below the end of one of the long sticks.

Flying this kite is much more fun if a kite reel is used. The reel is simply a magnet wire or other large spool with two large flanges or end pieces sawed from very thin wood and glued to the ends. The spool is



Strips of bright cambric are glued to the frame and then the bellyband is added

fastened in a small box by means of an axle made from a dowel or other round rod.

Where one end of the shaft passes through a hole in the side of the box, it is held in place by a washer and a cotter pin or a nail run through a hole in the shaft. To the other end, outside the box, is fastened a wooden crank, as shown, by means

(Continued on page 94)

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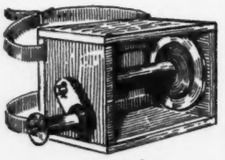
THE HOME WORKSHOP

Making a Simple Box Kite

(*Continued from page 93*)

of a screw or nail, a washer being placed between the crank and the box.



The completed kite reel

A short length of dowel is fastened with glue and a brad in a hole in the outside end of the crank, so that a spool can be slipped over it to form a handle. This spool is held on its spindle with a washer and cotter pin and should turn freely.

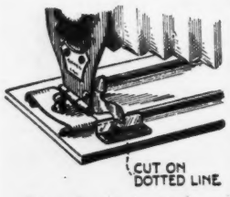
Two school straps run through slots cut at the back of the box are for fastening the reel to the body.—C. M. G.

Taking Large "Closeup" Photos with a Folding Camera

BY USING a portrait lens and extending the bellows of a single lens camera a little more than usual, it is possible to take photographs of small objects and documents so that the image fills practically the entire plate or film. Shortly after the war I photographed many honorable discharges for soldier friends in this way.

All that it was necessary to do was to file off a portion of the stop on the bed of the camera to allow the lens to be drawn over to the edge of the bed. In this position, and with the addition of a portrait lens, it is possible to take photos at a distance of 13½ in. from the camera, as opposed to the 3 ft. that is ordinarily required when a portrait lens is used at the 8-ft. focusing point.

For objects or documents too large to photograph at 13½ in., it is necessary to focus the camera before the film is inserted, and to measure the distance between the object and the lens. In cameras such as mine, which takes a picture 2¼ by 3¼ in., a ground glass cannot be used; therefore I use a piece of bond paper, oiled with a light machine oil, on which to find the focus and locate the object. The object is then left where it is, the position of the camera is marked, the film is inserted, and the picture taken at the distance found correct.



Stop is filed off to allow bellows to be extended

I secured the best results by using two 60-watt lamps located about 2 ft. from the object, and in front of and about 2 ft. apart, one on each side of the camera the right of the lens. These lights were backed with reflectors of white cardboard. An exposure of four minutes with the smallest stop gives a cleancut, sharp picture, but the time varies with conditions.—M. C. EVERETT, Chicago, Ill.

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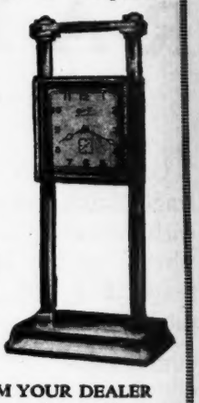

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Bulletin No. 2-P describes this new tube in full and gives the necessary data regarding rheostats, battery voltages, transformers, etc. A free copy will be sent to you by return mail, upon receipt of your request at either of the addresses given below. Complete instruction sheet for its care and operation is packed with each of these New Cunningham Dry Battery Tubes, type C-299.

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THE HOME WORKSHOP

Framework of Pipe Supports Simple Portable Garage

By R. C. Liebe

THE garage question is a serious proposition for many men who do not own their own home or who, like the writer, are compelled by their business to move from place to place. After building five garages in as many towns or locations, I designed two knock-down or portable garages and constructed the one illustrated.

The framework consists of ¾-in. galvanized pipe and fittings. There are three separate frames, one on each end and one in the middle. The pipe is thoroughly

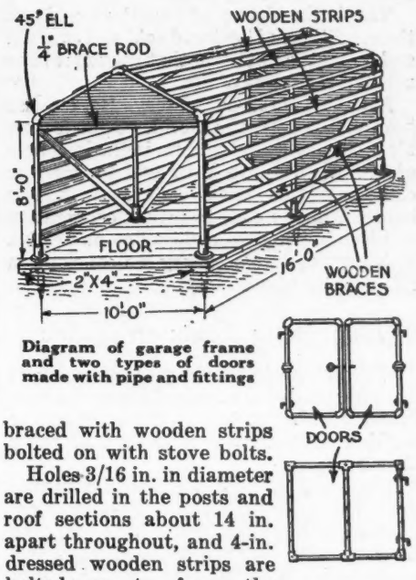

Diagram of garage frame and two types of doors made with pipe and fittings

braced with wooden strips bolted on with stove bolts.

Holes 3/16 in. in diameter are drilled in the posts and roof sections about 14 in. apart throughout, and 4-in. dressed wooden strips are bolted on to form the sheathing. The roof is covered with heavy tar paper, and the sides and ends with 8-oz. tenting. The duck is then given a coat of auto top dressing, so that the color of the garage throughout is black.

With a helper I can make this garage ready for my car in several hours, and it takes even less time to pull it down and pack it up in bundles for shipment.

The piping required for a garage 10 ft. wide, 8 ft. high and 16 ft. long consists of six posts 8 ft. long, six "rafters" 6 ft. long, and nine 45-degree ells. For a Ford car the garage can be 1 ft. less both in length and width.

The diagram is practically self explanatory. The builder can brace the garage as much as he thinks necessary to meet weather conditions. Iron spikes driven into the ends of the posts and then set into the ground serve to anchor the structure. If a wooden floor is to be used, a sufficient number of sleepers should be laid to support the heavy planking.

Each of the three pipe frames is held together by a ¼-in. rod bolted through the posts and tightened from the outside. Canvas curtains can be hung on this rod to form the cheapest kind of door, or one of the other doors shown can be used. These are pipe frames covered with canvas or wooden strips and tar paper or both.

A VARNISHED floor can be kept in good condition by rubbing it at intervals of every two or three months with an inexpensive mixture of equal parts of sweet oil, turpentine and vinegar. Apply the cleanser with a soft rag or cotton waste.

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Pioneer Cavemen Who Invented Civilization

(*Continued from page 35*)

ture, the adventure which is still going on. He was ready to begin trying to control his world.

This is an enterprise that no other animal has ever attempted. The evolutionary history of most creatures falls into one single story, the story of how the conditions of life in the world have shaped the living thing so that it fits into them, of how the giraffe got a long neck so that he could eat leaves off the tops of trees, or of how the tiger developed his stripes so that he would be invisible among the striped shade and sunlight of the long grass.

This is the history of how the world and the conditions of heat and cold and sunlight and animal competition that exist in it have affected the forms of life.

Man has shared this history. He, too, has been affected by the world. That is how his body was forged for him in the long ages of evolution, as we have told in previous chapters of this serial. This is how he was induced, in the end, to invent cooperation and live together in civilized communities. This part of man's history we conclude in this chapter of our story.

Man Turns Tables on Nature

We still have to tell the greatest and most inspiring part of the story of man—the part in which he begins to turn the tables on the world and to change it instead of being changed by it.

The story of man's adventure in the world is like that of a castaway on a desert island. In the beginning the island changes the castaway. It hardens his muscles and toughens his feet and tans his skin. But when these things have been done, after the castaway has yielded for a while to the pressure of his island, it becomes the castaway's turn. He begins to change the island. He cuts down the trees that he does not want and plants those that he does. He exterminates the kinds of beasts that he does not like. He dams a stream of water and changes its course so that it will run past his dooryard. He makes over the island to suit his idea of what a home-like island should be.

And man, cast away on this little speck of an earth, perhaps an exile from some larger civilization that he does not remember, is making over his earth, slowly but surely, so that it shall be more like the place in which he wants to live.

For Further Reading

THE best account of the New Stone Age is Tyler, "The New Stone Age in Northern Europe," referred to in the previous chapter of this serial. The best general history of the world, including all the essentials of the origin of civilization, is H. G. Wells' "The Outline of History" (The Macmillan Co., New York, 1921). On the beginnings of the ancient civilizations see J. L. Myers' "The Dawn of History" (Henry Holt & Co., New York, 1911). The best scientific summary of what we know about early Egypt, Babylonia, and Crete is "The Ancient History of the Near East," by H. R. Hall (Methuen & Co., London, 1920).

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THE HOME WORKSHOP

Building an Iceless Icebox

(*Continued from page 73*)

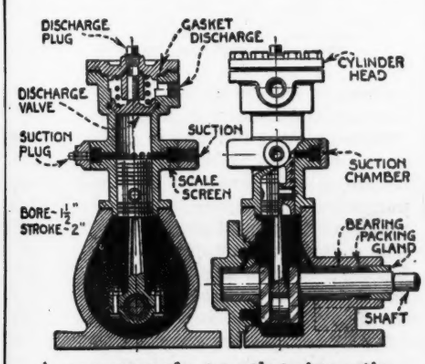
cylinder walls into the gas chamber and this must be caught and returned to the crankcase from time to time. If allowed to pass on through the system, it will clog and congeal at the expansion valves and coat the interior of the coils, reducing their efficiency.

The oil trap is a piece of extra heavy 3-in. pipe about 10 in. long. Heads and sockets for the outlets are welded in as shown. The ingoing pipe from the compressor is welded on a tangent, which gives the inrushing gas a whirling action and causes the oil to cling to the walls, while allowing the gas, thus freed of oil, to rise out of the pipe on top. The lower socket should extend a little above the bottom of the trap, to preclude the possibility of any accumulation of scale stopping up the drain valve.

The next unit is the condenser, the part of the mechanism in which the hot gasses are cooled by coming into contact with pipes filled with the cooling agent, water. In small sets the receiver is combined with the condenser and the two are thus made in the same piece.

A shell of extra heavy pipe is worked up to the dimensions given. Each end is threaded externally and internally, as shown. A counterbore at each end is provided for the seat of the heads, being wide enough merely to hold the heads in place. The tubes are made of ½-in. heavy pipe with the ends turned down to fit into the drilled and reamed holes of the heads.

When assembling the parts, one head is put in place and its ring is screwed down tightly. The tubes are then inserted and the other head is put in place and its ring is screwed down. Before assembling, all the tube ends and the whole surface of both heads, as well as the interior surfaces, are well tinned with the best solder. Each



A compressor of a type that gives satisfactory service for a small refrigerating plant in the home

head is made with a solder groove, as shown, and this will always guarantee a good joint when the joint is heated hot enough to make the solder flow.

The tube ends are peened or turned over, as shown, after which melted solder knits together the tinned surfaces and makes the whole a pressure tight affair. Thin water flanges are screwed to the outer threads and blank sheet heads are fitted and bolted to retain the water.

A baffle plate is placed between the water and condenser heads to cause the ingoing water to pass through the four lower pipes or tubes and return through the upper five. The water inlet pipe is ⅜ in.

(*Turn to page 98*)

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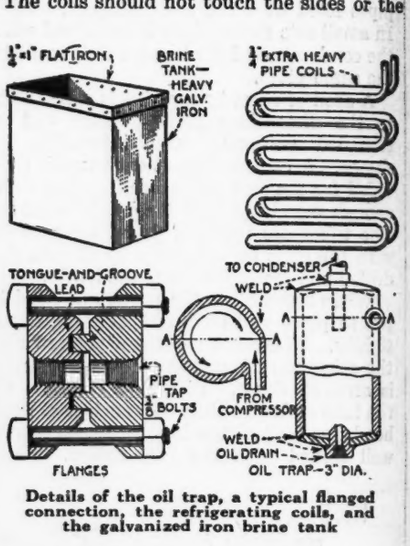
THE HOME WORKSHOP

Building an Iceless Icebox

(*Continued from page 97*)

in diameter, while the discharge is ½ in. The discharge is piped to a water drain. Sockets are welded for the incoming and outgoing ammonia. Large units have gage glasses on the condensers to show the height of the fluid or liquid ammonia, but this is not a necessity on a small outfit, and the freedom from trouble caused by leaky valves and packing more than offsets the absence of gage glasses.

The coils and the brine tank are the remaining elements. For the former, coils are bent in the pipe shop to the shape shown, extra heavy ¾-in. pipe being used. The bends should be close, to get as much pipe into the tank as is possible. The ends are threaded and fitted with ells. The tank is of heavy galvanized iron, reinforced around the top with ¼ by 1 in. flat iron. It should fit the ice compartment of your refrigerator, allowing 2 in. of space on sides and bottom, and at least 6 in. on top. The coils should not touch the sides or the



Details of the oil trap, a typical flanged connection, the refrigerating coils, and the galvanized iron brine tank

bottom of the tank, but, for best results, should stand about 1 in. away.

When placing the tank in position, stand it on two pieces of hard wood, about 2 in. square, placed crosswise in the ice compartment. This space around the tank is necessary for a good circulation of cold air. The coils are also supported on hard wood blocks, 1 in. high, so as to allow the brine to circulate around the cold pipes. The brine for filling the tank is made by dissolving 3 2/3 lbs. of calcium chlorid to a gallon of water, which makes a solution that freezes about zero, a temperature so low that it is never reached by the machine.

Standard ammonia valves and fittings should be used. These can be obtained from refrigerating supply houses as well as large dealers in general machinery supplies. The charging valve has a through opening for the ammonia line and a controlled opening for use when charging the system with ammonia.

The operation of the system, when completely assembled, is as follows:

Testing out. Open discharge valve on compressor, also outgoing ammonia valve, together with the expansion valve leading directly into the coils. Keep the suction valve closed, and open the suction plug. Close the gage valve on the suction side, and open the high pressure gage valve on the high pressure side. Start up the ma-

THE HOME WORKSHOP

chine and pump pressure up to 250 lbs. a square inch. Allow the outfit to stand idle for a while and there will be a gradual lowering of the pressure, due to the cooling of the highly compressed air. After this has ceased, the air pressure should remain constant, provided all the joints are tight. With a brush and soapsuds paint all the joints; leaks will show in the form of bubbles. If the system tests out all right, we are ready to charge.

Charging. Screw in the suction plug, smearing it well with litharge, and open up the discharge plug on the top of the cylinder head. Close the discharge valve, open the suction valve, and pump out the air in the system, until both gages show a vacuum of from 20 to 30 in. Then screw in the top plug, and the system is ready for charging the ammonia. Connect the ammonia drum to the "king" or charging valve. Close the ammonia line valve, but leave the expansion valve open. Open the discharge and suction valves, and start up the machine. Then open the valve on the ammonia drum just a trifle and allow the gas to expand into the coils slowly, controlling the flow so that the gage on the low pressure side does not show more than about 15 lbs. back pressure. Gradually, as the ammonia fills over on to the high pressure side and into the receiver, the high pressure gage will rise, and when this pressure has mounted to around 170 or 180 lbs., the system is charged. The ammonia is turned off and a vacuum is pumped on the low pressure side of the system.

Purging the System

When the pipe connection between the charging valve and the drum starts to freeze up, then the charging valve is closed tightly, and the connection is broken. Because of a small amount of air in the system, caused by the failure to exhaust completely the cylinder head cavity, the system must be purged, and this is done by removing the high pressure gage and screwing in a short nipple, over which is pulled a short hose. The hose is put into a bucket of water and the valve is opened up a bit. The air, saturated with ammonia, will bubble into the water and when the pure ammonia gas has driven the air out, the hose will frost up. The valve is then closed, and the system has been purged.

If at any time the pressure should mount above the original initial pressure, examine the temperature of the cooling water, and if this is not above the lukewarm condition, the system has again taken in a quantity of air through the stuffing box during the periods when a vacuum was being pumped.

When running to cool the brine tank, have around 15 lbs. back pressure on the low side and run until the brine has been cooled to 20 degrees above zero, which temperature will hold the box for a long time and will keep food products at their best condition.

Before shutting down, close the ammonia line valve, and pump the low side down to a vacuum, after which close the suction valve, throw off the motor switch, and then close the discharge valve. The water valve is the last to be closed and the first to be opened, and just enough water should be allowed to pass through the condenser so that the outgoing pipe is lukewarm.

How to build a small ornamental fountain for the garden or indoors will be told in the August issue.

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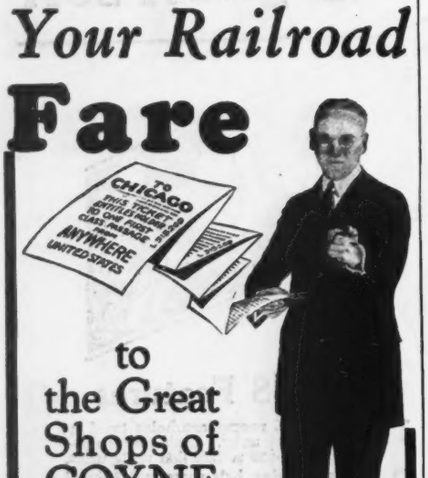

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THE HOME WORKSHOP

Rigging a Canoe Sail

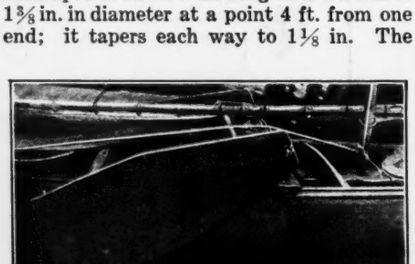
(*Continued from page 75*)

make a hem 1 in. wide and pinned in place before the edges are sewn.

The leech, being the finished edge of the cloth, is turned over only once in a 1-in. fold; the head and foot of the sail are turned over twice in 1-in. folds, after trimming to the cord. All the folds are pinned 1 ft. apart and the pins are removed as they are met in sewing.

Number 1 brass grommets or eyelets are evenly spaced along the head and foot of the sail, about 9 in. apart, and one is placed for the flag at the top of the leech about 10 in. below the point of the sail.

The mast is 5 ft. long over all, and tapers from 2 in. in diameter at a point 10 in. from the lower end to 1½ in. at each end. The head spar is 11 ft. 6 in. long over all and is 1⅜ in. in diameter at a point 4 ft. from one end; it tapers each way to 1⅛ in. The



How the finished leeboards look. Note the bulkhead and part of the mast mounting at the right

foot spar or boom, which is also 11 ft. 6 in. long, is 1½ in. in diameter at the middle and tapers both ways to 1¼ in.

The method of joining the head spar to the foot spar, and the spars to the mast is shown in detail. A pulley is inserted, as indicated, in a slot at the top of the masthead.

The leeboards in use are never placed at the widest part of the canoe, but 1 or 1½ in. back from the mast; the correct position can be found by experimenting when trying out the sail. When sailing across the wind, or tacking, the paddle should be lifted from the water. If the boards are at the right spot, the canoe will immediately come up into the wind.

The illustrations on page 75 show how the sailing outfit looks in connection with a 17-ft. canoe. Since taking the above photograph of the leeboards, braces such as are indicated in the mechanical drawings have been substituted for the wooden cross brace, as they are neater.

Complete working drawings for this sailing outfit and a bill of materials are contained in Home Workshop Blueprint No. 25, which will be sent by POPULAR SCIENCE MONTHLY to any reader for the nominal price of 25 cents to cover the cost of blueprinting and handling.

WHEN it is necessary to make porous concrete watertight, paint it with one part of sodium silicate or waterglass in 3, 4, or 5 parts of water. Give additional coats every 24 hours until the pores of the concrete are filled. Another waterproofing solution is 5 lbs. of powdered alum and 1 lb. of lye to 10 qts. of water. One half pint of the solution is used in every pail of water required for mixing the cement. For external application, use ½ pt. mixture in a bucket of water thickened with pure cement.

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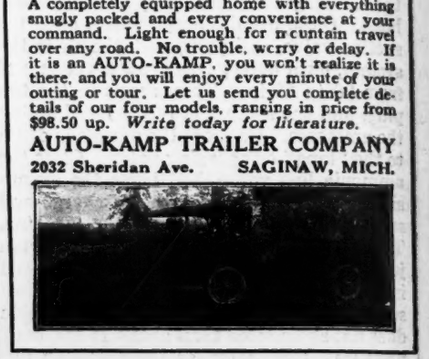

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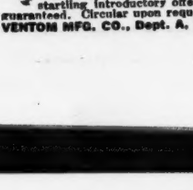

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How Much Do You Know about Science?

FOLLOWING are the correct answers to the 30 questions on fundamental facts of science printed on page 64 of this issue. Grade yourself 10 points for each question answered correctly and see how near you come to a 100 per cent score for each classification.

The Story of the Stars

1. The latest and best estimate—that of Dr. Harlow Shapley of Harvard College—is that the group of all the stars that we can see in a telescope and that astronomers call the galaxy, is about 300,000 light-years from side to side. This means about 1,764,000,000,000,000,000 miles. It is possible that some of the nebulæ are outside of this and therefore even farther away.
2. The air is not perfectly transparent. It makes light waver a little, just as things outside seem to waver when we look through a window pane of imperfect glass. This wavering of the light from the stars make them seem to go out altogether from moment to moment. That is, they twinkle.
3. Perhaps a few of the stars are like the earth, but most of them are not. There really are two kinds of stars—dwarfs and giants. The dwarf stars are about the same size as our sun. They are fairly dense, like a liquid or a very highly compressed gas. The giant stars, on the other hand, are made of very thin, highly rarefied gases. Most of them are far thinner even than air.
4. This is an optical illusion. The stars are so far away that we can see them only as points of light; not as round or as any other definite shape. The pointed appearance is a mistake of our eye.
5. We may be quite sure that the future cannot be foretold by the stars. Scientists do not believe that it can and no one has ever been able to prove the contrary.
6. The moon, as it moves around the earth, happens to get exactly between us and the sun, causing an eclipse of the sun.
7. Because it is hot. Sunlight is the same thing as the light from a piece of white hot metal except that it is on such a tremendously larger scale.
8. Because it reflects back to us the sunlight that falls on it, just as though it were a mirror.
9. The moon seems to be made of rocks about like those of the earth.
10. The earth and everything on it would be burnt up. Probably there would be so much heat produced by the smash that even the rocks would be turned into gas.

The Story of the Earth

1. The best proof is that ships can sail around it. There are many other proofs. The earth's shadow on the moon is round, as seen in eclipses. The curvature of the earth can actually be measured by delicate surveying instruments. Wireless signals can be sent around the earth and back to the sending station.
2. No. The speed at which earthquake shocks pass through the earth from one side to the other, proves that the earth is rigid all the way through, even more rigid than steel. It may be that the inside of the earth is hot but is kept from melting by the tremendous pressure of the miles of rock above.
3. Because the water rolls the stones around all the time and wears off their corners by knocking them together.
4. Yes. Man and monkey are descended from the same ancestral stock, though the human branch and the monkey branch separated many millions of years ago. It is not scientific to say that man is descended from monkeys.
5. The greatest known depth of the sea

(*Turn to page 102*)

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How Much Do You Know about Science?

(*Continued from page 101*)

is a little over six miles or 32,088 feet. This deepest place is in the Pacific Ocean near the Philippine Islands.

6. Four fifths of the air is nitrogen gas. One fifth of it is oxygen gas. The gases are not combined chemically; they are merely mixed together. Air also contains several gases that are present in very small quantity. The chief one of these is argon.

7. The air in one place gets heated, usually because the sun shines for a while on the land underneath it. This heated air rises, making a partial vacuum. Air from all around rushes in to fill the vacuum. This makes wind.

8. The little water drops in the clouds are made by a lot of water molecules condensing together. If this goes on long enough, the drops get so large that they fall down as rain.

9. When the air is cold enough, the water molecules, collected together, form a little crystal of ice instead of a liquid raindrop. These ice crystals are the snowflakes.

10. Because clear air allows more heat to be lost from the ground and from the layers of air next to the ground. Clouds act as a sort of blanket and keep the heat in so that the temperature does not fall quite so low.

Every-Day Chemistry

1. Certain substances, like coal, can combine chemically with the oxygen of the air. This is a chemical reaction producing heat. The heat makes the fire.

2. Incomplete burning of the gasoline or oil in the cylinder. There is carbon in gasoline and in all motor oils. Some particles of carbon are left unburned after the explosion in the cylinder and are thrown out as smoke.

3. Iron combines chemically with the oxygen of the air and with water vapor, which also may come from the air. This makes a compound called hydrated oxid of iron. This compound is red. It is the rust.

4. Dip a piece of cloth in a strong solution of soda lye. Wool will be eaten away; cotton will not be affected.

5. Milk turns sour because a certain kind of germ grows in it, the germ called the lactic acid bacterium. This bacterium converts the sugar of the milk into an acid substance called lactic acid, which has a very sour taste.

6. The yeast used in making bread is the same little living plant that is used in making alcohol. Bread dough contains a little sugar derived from the starch of the flour and the yeast converts this sugar into alcohol. At the same time it produces a lot of little bubbles of carbon dioxid gas. It is these bubbles that make the bread rise.

7. Strictly speaking, bluing does not bleach clothes at all, it merely turns them a little blue. Washed clothes are likely to be a little yellow. Any painter will tell you that blue tends to neutralize yellow. So the small amount of blue tint added by the bluing makes the clothes appear whiter than before.

8. No. Thunderstorms have no effect on milk at all. The common idea that they have, probably comes from the fact that a summer thunderstorm is likely to come up toward the end of a very hot day. It is the hot day that sours the milk, not the storm.

9. Salt absorbs water from damp air. The surface of each little grain becomes moist. This makes the grains stick together.

10. The air contains a small amount of sulphur gases, derived, usually, from the sulphur contained as an impurity in coal and other fuels. Silver has a great affinity for sulphur. It takes up the sulphur gases from the air and forms a black compound called sulphid of silver.

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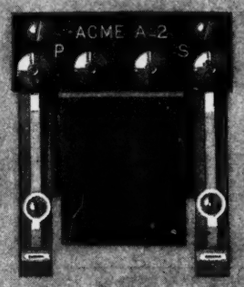

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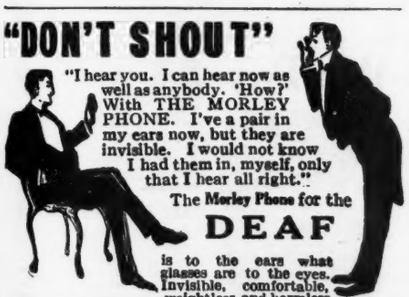

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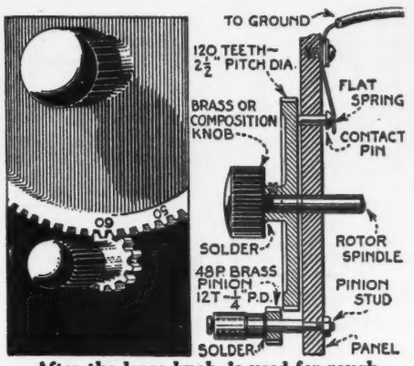
THE HOME WORKSHOP

Brass Gear Serves as Dial

(*Continued from page 74*)

The Vernier attachment consists of a 12-tooth brass pinion of the same pitch as the "dial," with a pitch diameter of ¼ in., and to this pinion a small knurled knob is soldered. The whole unit is free to slide on a shouldered stud anchored to the panel.

Many amateurs do not favor the use of metal dials, but if the dials are grounded, they serve as a "shield" and are equal to, if not better than, composition dials. The grounding is accomplished by means of a brass pin free to move in a hole in the panel and forced by a flat spring into "brush" contact with the back of the gear. The screw serves to hold the spring in place



After the large knob is used for rough tuning, the pinion is pushed into mesh to obtain Vernier adjustments

and provides an attachment for the ground wire, the other end of which is connected with the ground terminal of the set.

The Vernier pinion is slid in and out of mesh with the dial, so that rough adjustments may be made with the dial knob and the finer adjustments with the Vernier. Since the gear has 120 teeth and the pinion only 12, the ratio between them is 10 to one, so that if the pinion is moved one degree, the motion transmitted to the gear causes it to move only one tenth of a degree.

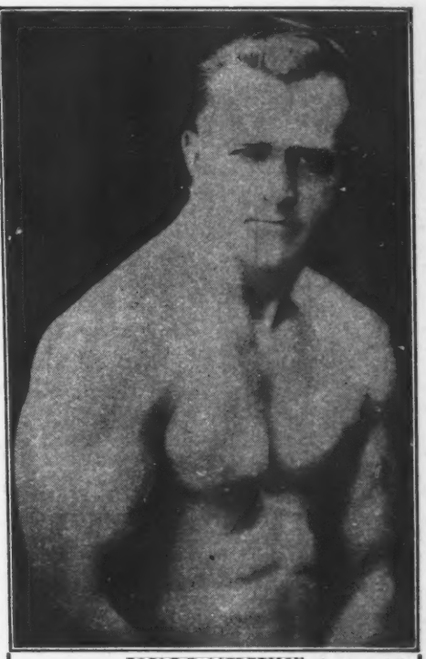
To give this unusual dial a finished appearance, it can be coated with aluminum paint and the numeral impressions filled with black drawing ink.

The gear and pinion combined should not cost more than a dollar and are obtainable from gear manufacturers or from dealers carrying modelmaker's supplies.—C. M. WILCOX, Torrington, Conn.

Improving Rotor Bearings

AN ENJOYABLE radio program coming through the writer's receiving set was turned into a barnyard chorus on several occasions because of the poor contact between the rotor spindle and its bearings. The bearings were of the common type—strips of brass, each with a bearing hole and a spring slot. After the instrument had been used a short time, the bearings, as so often happens, failed to grip positively.

Brass eyelets or short lengths of brass tubing with a hole the same or a trifle larger than the rotor spindles were slotted with a hacksaw and soldered to the bearing strips. These increase the bearing surfaces so that good contact is insured.—W. M.



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How Do You Look in a Bathing Suit?

The good old swimming days are here. Oh boy! But it's great to rip off the old shirt, into your suit and take the splash. But what a shock to some of the poor girls when they see their heroes come out with flat chests and skinny arms instead of the robust frames they expected to see.

You Can't Fool Them

Don't try to make excuses. You should have knobs on your arms like a baseball. A fine protector you would make, when you can't even fight your own battles. What are you going to do? She is going to find you out.

Look Your Best

It's not too late. I can save you yet. It means hard work and plenty of it, but think of the results. In just 30 days I am going to add one full inch to your biceps. Yes, and two inches on your chest in the same length of time. But that's only a starter. I am going to broaden out those shoulders and put real pep into your old backbone. You will have a spring to your step and a flash to your eye, showing you to be a real, live man. Before summer is past you won't recognize your former self. You will have a physique to be really proud of. This is no idle talk, fellows. I don't promise these things. I guarantee them. Come on and make me prove it.

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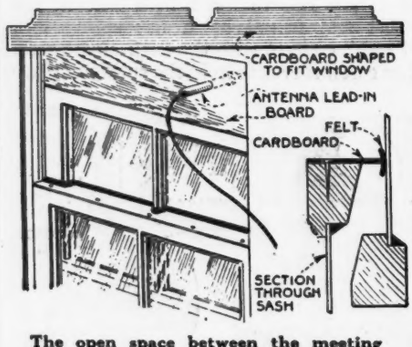
THE HOME WORKSHOP

Preventing a Draft from Radio Lead-in Windows

USUALLY the simplest method of bringing an aerial lead-in indoors is through some part of the window. A narrow board is often placed either at the bottom or top of the window, as shown, and a hole bored in it for the porcelain insulator.

The objection to this method is that the meeting rails of the sash no longer come together and therefore a considerable draft can enter the room. To prevent this, cut



The open space between the meeting rails is filled with a felt-edged strip of cardboard, wallboard, or wood

out a piece of wallboard, stiff cardboard, or even thin wood to the shape of the sash, as shown, and glue a length of felt weather strip to the edge. The strip is then pushed firmly against the glass and fastened with tacks to the meeting rail of the lower sash.—FRANK W. HARTH.

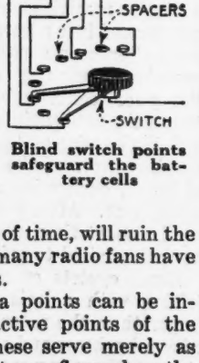
Preventing Storage Battery Noises

SOMETIMES bubbling and irregular action of a storage battery will cause noises in a radio receiver. These often can be stopped by shaking up the storage battery.

Spacers Prevent Short Circuiting Radio B Battery Switch

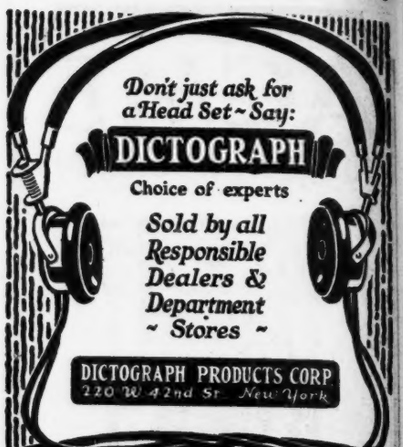
TO CHANGE rapidly the voltage of a radio B battery, it is convenient to use a switch with several contacts. Usually five are sufficient, since 16½ volts is about the lowest point at which a gas detector bulb functions satisfactorily, and 22½ volts the highest, the space between being divided into intervals of 1½ volts.

There is, however, a disadvantage in mounting the contact points of the switch successively, because if the switch arm is so wide or the contacts so close together that the end of the blade touches two points at the same time, the cell between the points will be short circuited. The switch arm, if left in such a position for any length of time, will ruin the short circuited cell, as many radio fans have discovered to their loss.



Blind switch points safeguard the battery cells

To avoid this, extra points can be inserted between the active points of the switch, as shown. These serve merely as spacers and no current can flow when the switch arm rests upon one of them.—H. F.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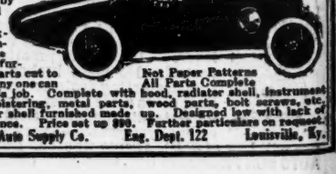

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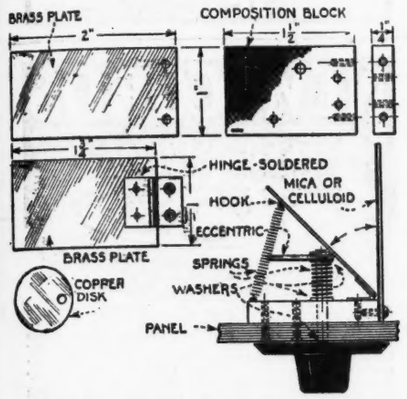
THE HOME WORKSHOP

Easily Made Vernier Condenser Tunes Radio Set Sharply

IN THESE days of extreme radio interference, perhaps the most useful addition to the average set is one or more Vernier condensers. The type illustrated can easily be constructed and is quite free from the effects of body capacity.

Two brass plates of heavy gage are needed. One should be 1¾ in. long and the other 2 in. long, both being 1 in. wide. A piece of insulating composition or hard rubber is also needed, ¼ by 1 by 1½ in.

A hinge is soldered to the shorter brass plate and fastened to the insulating block with 6/32 screws, after the block has been drilled and tapped to take them. Holes are drilled in the larger plate, as shown, and a thin piece of mica or celluloid is attached



Fine adjustments in tuning are made possible by this small, panel-mounted condenser of the "book" type

to one face of the plate with shellac. A piece of photographic film will serve.

The easiest way to fasten the mica or celluloid is to heat the plate until flake shellac will melt into an even coating when rubbed over it. The mica or celluloid should then be laid on and the plate put under pressure on a flat surface until the shellac is hard. The plate is then fastened to one end of the block with two screws.

The capacity of the condenser is varied by moving the hinged plate toward or away from the fixed plate. This is accomplished by turning a cam made from a brass or copper disk about the size of a penny, drilled at one side and fastened to the shaft so that the movement will be eccentric.

Washers placed as shown will insure the shaft turning smoothly and the spring provides sufficient tension to prevent the pressure of the movable plate from rotating the shaft. Another spring is fastened between the plate and the block, care being taken that it does not interfere with the movement of the cam.

One wire lead should be soldered to the fixed plate and another to the movable plate or to the spring connecting with it, and these leads should be connected around the large condenser. The Vernier is then in parallel with the large condenser and permits extremely delicate adjustments to be made in varying the capacity of the circuit.—H. H. HOUCK, Rochester, N. Y.

THE radio beginner will do well to mount the set he is making on a plain board first and use it for some time before placing it in a cabinet. It is then easy to experiment with the set until it works well.

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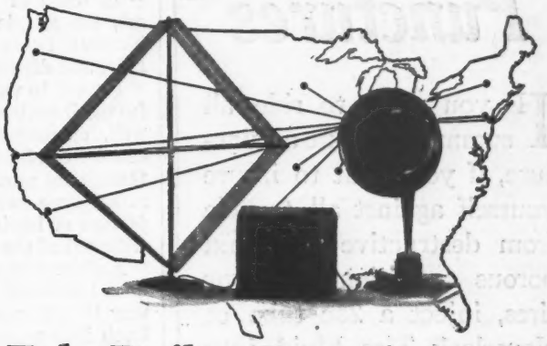

Erla Bezels, in 1" and 1½" sizes, have telescoping rim that fits any ½" to ¼" panel. Nickel or black enamel. 20c

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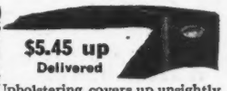

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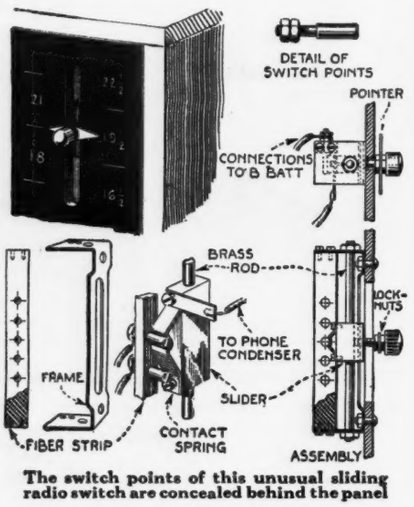
THE HOME WORKSHOP

Unique Switch Gives Distinction to Homemade Receiving Set

IF YOU wish something original for one or more of the switches on your radio set, the simple sliding switch mechanism illustrated will be found a neat, serviceable, and distinctive arrangement.

I use it to vary the plate voltage current for the B battery, but it would serve equally well, of course, for the taps of a variocoupler or other variable inductance. Although not as easy to install as the common radial type switch, it gives one the satisfaction of having a radio device that is a trifle out of the ordinary.

A slider with a contact spring is arranged on a brass rod behind the panel in such a way that it can be moved by means of a knob into engagement with switch points. A brass strip soldered to the spring and projecting to one side about 1 in., carries the current to the phone condenser through a flexible wire, and the terminals of the B battery are connected with the switch points. These are mounted one below the other on a fiber, hard rubber, or composition strip.



The switch points of this unusual sliding radio switch are concealed behind the panel

A strip of sheet brass about 1/16 in. thick is bent up, as shown, to form the frame, and a slot is provided for the slider, as well as holes for the screws to attach the strip for the switch points. The slider itself is made of fiber, and the contact spring is a light gage of spring brass.

A brass rod is mounted on the frame by means of terminal nuts to act as a guide for the slider, which is kept from turning by the guide slot in the frame.

The slider is manipulated from the front of the panel by moving a brass screw with a knurled edge. This knob is provided with a pointer held in position with locknuts.

Graduations engraved on both sides of the panel slot and filled with white paint give the finishing touch to this novel switch.—A. M. C.

A POTENTIOMETER will often increase both the selectivity and sensitivity of a receiver. In order to connect a potentiometer into the circuit, take out the wire leading from the negative of the B battery to the A battery and connect the negative of the B battery with the sliding member of the potentiometer. One end of the resistance element is then connected with the negative of the storage battery and the other end with its positive terminal.

MAKE GAS IN ANY STOVE

Cook in a Cool Kitchen

The Instant-Gas Oil Burner Makes summer cooking a pleasure. Gives you gas anywhere, everywhere, in any stove or range. Everybody knows gas means cleaner, cheaper cooking and a cooler kitchen. Saves hours of time and loads of dirt. Start your stove with a turn of the wrist, turn high or low to suit and stop with another turn of the wrist.

Fits Any Coal or Wood Stove Different models for different stoves. Just set it in the fire-box. Put in or taken out in ten minutes. No damage to stove. Simple, safe, odorless, lasts a lifetime. Money-back guarantee.

30-Day Trial The Instant-gas Oil Burner makes its own gas from coal oil (kerosene) at one-sixth the cost of city gas. Much cheaper than coal or wood. Because it can be regulated the Instant-gas Oil Burner Cooks and Bakes Better than coal or wood in the same stove. No coal or wood to carry, no ashes, no chopping, shoveling or starting of fires. Greatest woman-saver in the world. Write for 30-day trial offer and free book telling how Uncle Sam burns oil.

USER AGENTS needed in every locality, to whom we can refer new customers. Send for our $60 a week sales plan, giving exclusive territory free.

INTERNATIONAL HEATING CO.
Dept. 139
116 S. 14th St. St. Louis, Mo.

NEW CORDS

10000 MILES GET 10000 MILES SERVICE 10000 MILES

30×3 $5.95

Sensational New Cord Tire Sale!

Our big volume business enables us to sell *brand new Cord* tires at lowest prices. Don't miss this Sale. Every Cord guaranteed first quality and new. Order your season's supply now and cut your tire cost in two. Thousands of steady customers getting full mileage and you, too, can get **10,000 Miles**

Size	Cords	Tubes	Size	Cords	Tubes
30x3	$5.95	$1.05	34x4	$11.75	$1.65
30x3½	6.90	1.25	32x4½	13.70	2.00
32x3½	7.25	1.30	33x4½	14.40	2.10
31x4	9.90	1.40	34x4½	14.90	2.15
32x4	10.85	1.45	35x4½	15 40	2.25
33x4	11.20	1.50	33x5	20.00	2.50

SEND NO MONEY

Just send your name and sizes of tires wanted. Don't wait! Price soon to go up. Take advantage of this sensational tire sale. Shipment C.O.D. Section unwrapped for inspection. Order now. Dept. 29

SUPREME TIRE CO., 3234 W. Jackson Blvd., Chicago

No Deposit

Just send your name, address and finger size, and we will send you this beautiful genuine diamond, 14K solid gold ring on approval. Send no money; pay no C. O. D. Merely accept the ring and wear it a week. Then decide—either return the ring and call the deal closed, or keep it and send only $3.75 a month until our cut price of $38.75 is paid. (Regular $50.00 value.)

Genuine Diamonds

Each ring is solid 14K green gold, with 18K white gold top, exquisitely hand engraved and set with a fine, large, extra brilliant, perfectly cut, blue-white genuine diamond. Order now—at once! Send name, address and finger size. Also kindly give your age and occupation and say whether you want ladies' or men's ring. Write today!

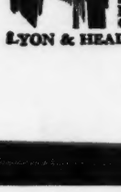
Harold Lachman Co., 200 So. Peoria Street Dept. B-178 Chicago, Ill.

DRIVE This Beautiful RACEABOUT INSTEAD OF YOUR OLD FORD

Fiat or Bullet Nose Radiator. Choice of four colors. Send for complete Catalog of Auto Bodies, Accessories and Speed Power Equipment. Direct from factory.

AMERICAN TOP AND BODY CO., Lee St., Delphi, Ind.

NEW CHAMPION CORNET OUTFIT $6.85 Down—then pay only $5 per month for four months!



Fine imported Cornet, polished brass; excellent valve action, tone, intonation; pearl finger-tips; EASY BLOWING; high or low pitch; in velvet-lined Keratol case; mute and mouthpiece, self-instructor. For sale by your Music Merchant. *Money-back Guarantee.* ORDER NOW!

LYON & HEALY, 72-79 Jackson Blvd., Chicago

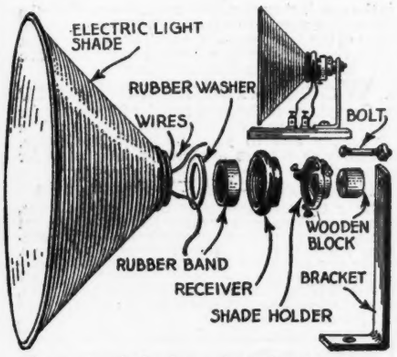
THE HOME WORKSHOP

Electric Light Shade Serves as Horn for Loudspeaker

ALL that is necessary to make a very cheap yet neat looking loudspeaker is a 1500-ohm telephone receiver, a common tin electric-light shade, a brass shade holder, and a few odds and ends to be found in almost any home workshop.

On a wooden base ⅞ by 4 by 8 in., screw a support made from a brass strip ⅛ by ½ by 7 in., drilled with a 3/16-in. hole ½ in. from each end, and bend as shown, 1 in. from one end. Prepare a cylindrical block 1 in. in diameter and 1 in. long with a 3/16-in. hole through the center and clamp it to the adjustable ring of the shade holder.

Fasten the block and shade holder to the top of the standard with a 1½-in. bolt. It

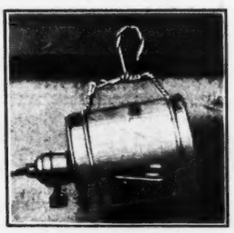


The parts of the lampshade loudspeaker in the order in which they are put together, with wooden bracket

will be found that the setscrew end of the shade holder will fit over the top of the telephone, the setscrews holding it fast.

Place a rubber washer between the face of the telephone cap and the small end of the shade, slip a wide rubber band over the joint, and fasten the shade firmly by wiring it to the setcrews in the shade holder. Flexible leads from the telephone are brought down to binding posts on the base.—GEORGE FREDERICK, Washington, D. C.

Coffee Can Makes an Adjustable Trouble Light Protector



THIS trouble light protector is made from a 1-lb. coffee can and a length of bailing wire. It protects the lamp, saves the worker's eyes from all glare, and at the same time serves as a very effective reflector.

The wire handle, being movable, can be set at any point on the circumference and the protector can be held or hung up with the light turned as required. It also will stand on its flat base on the workbench or other support. This flexibility makes it even more desirable, to my mind, than the usual wire lamp guard.—R. A. FRANKLIN, Rochester, Minn.

A VACATION radio set of unique design and with only one control will be described in the Home Workshop next month.

Down goes the price!

BOXING Jiu-Jitsu Wrestling $1.97 Was $5.00

Think of it! For only $1.97 you can now have the famous Marshall Stillman Course—the same identical $5.00 course by which Marshall Stillman has taught boxing, jiu-jitsu and wrestling to over thirty thousand men! *You can have it on ten-day trial—send no money.*

Over eighty complete lessons—six volumes, hundreds of pages and over two hundred illustrations—all for $1.97, or less than three cents a lesson!

He teaches you right in your own home. You learn all the fundamentals of boxing and the blows and guards used by the topnotchers—the Benny Leonard Triple, the Jack Dempsey Triple, the Fitzsimmons Shift, etc. All the secrets of the ring, all the fine points of feinting, ducking, clinching, breaking ground, judging distance and timing—including three lively rounds of *Shadow Boxing* to develop speed and confidence. In short, you will become a good boxer in quick time—able to box rings around that "fellow who thinks he knows it all"—and for only $1.97.

In *Jiu-Jitsu* you will learn how to disarm an opponent, how to break a stranglehold, etc., and, in *Wrestling*, the Gotch Toe Hold, Stecher Scissor Hold, the Head-Lock, etc.

With the course you get a Free History of Sixty-nine Famous Boxers, with their pictures and "inside" stories about them.

SEND NO MONEY. Simply fill in and mail the coupon. When you have the course in your hands, deposit 97 cents (plus the actual postage) with the postman. Then examine the course for ten days—try it thoroughly. At the end of ten days, either send us the small balance of $1.00 in final payment, or return the course and we'll send your deposit back. Marshall Stillman Association, Dept. 1123-F, 42nd Street and Madison Avenue, New York.

COUPON

MARSHALL STILLMAN ASSOCIATION
Dept. 1123-F, 42nd St. and Madison Ave., N. Y.

You may send me on approval the Marshall Stillman Course. I will deposit 97 cents (plus the actual postage), with the postman, with the understanding that if, after ten days, I wish to return the course I may do so and my money will be instantly refunded. If I keep the course, I am simply to send you $1.00 in final payment.

Name.....

Address.....

NOTE—Canadian and foreign orders must be accompanied by cash ($1.97 U. S. funds) subject to money back if not satisfied.

$25.00 in Prizes

See page 4 in front of book for full details

$3 DOWN *brings genuine*

UNDERWOOD

Yes, only $3 down puts this genuine standard Shipman-Ward Rebuilt Underwood in your home. Then—small monthly payments, or if convenient, pay cash. Either way you get the *world's standard* typewriter at a big cash saving.

WHY PAY RENTAL?

Think of it! You pay little more than rental, and the machine is yours! We offer the same three models of the Underwood Typewriter which are being made and sold by the Underwood Company today. The only difference is that Shipman-Ward machines are priced lower and are rebuilt like new by experts. You can't tell them from brand new machines. Visible writing—the FULL LINE of typewriting is visible at all times. STANDARD 4-ROW SINGLE SHIFT KEYBOARD. Two color ribbon, back spacer, stencil device, automatic ribbon reverse, tabulator, etc.

TEN DAYS' FREE TRIAL

See for yourself! Try the typewriter ten days. You must be satisfied or the entire transaction won't cost you a penny. Act today. Get our big illustrated catalog and full particulars. Write NOW.

FREE TRIAL COUPON

Typewriter Emporium
SHIPMAN-WARD MFG. CO.
B-214 Shipman Bldg., CHICAGO

Send by return mail Bargain Offer No. B-214 of a Standard Visible Writing Underwood. This is not an order and does not obligate me to buy.

Name.....

Street or R.F.D. No.....

Postoffice..... State.....

Sent on Approval

21 JEWEL

No Money Down

While other watch dealers are raising their prices, asking you for larger monthly payments, and making payment terms harder for you to meet, we are offering you our new model Santa Fe Special, no advance in price, no money down, easier terms and smaller monthly payments. WE realize the war is over and in order to double our business we MUST give you pre war inducements, better prices, easier terms and smaller payments.

LOOK

Adjusted to Positions
Adjusted to Temperature
Adjusted to Isochronism
Adjusted to the Second
Thin Model. All Sizes

Without one penny of advance payment let us place in your hands to see, to examine, to inspect, to admire, to approve, a real masterpiece in watch creation. A Watch which passes the most rigid inspection and measures up to the exacting requirements of the great Santa Fe Railway System, and other great American trunk lines.

Page 12 of our Watch Book is of Special Interest to You

Ask for our Watch Book free—then select the Watch you would like to see, either the famous Santa Fe Special or the 6 position Bunn Special, and let us explain our easy payment plan and send the watch express prepaid for you to examine. No Money Down. Remember—No money down—easy payments buys a master timepiece—a 21 Jewel guaranteed for a lifetime at about half the price you pay for a similar watch of other makes. No money down—a wonder offer.

SANTA FE WATCH COMPANY
780 Thomas Bldg., Topeka, Kansas
(Home of the Great Santa Fe Railway)

A Letter, Post Card or this Coupon Will Bring My Beautiful Free Watch Book

SANTA FE WATCH CO.
780 Thomas Bldg., Topeka, Kansas

Please send me your New Watch Book with the understanding that this request does not obligate me in any way.

Name.....

Address..... State.....

This Man Wouldn't Stay Down

HE was putting in long hours at unskilled work. His small pay scarcely lasted from week to week.

He saw other men promoted. Then he learned the *reason*. They had special training. He made up his mind to get that kind of training.

He sent to Scranton a coupon like the one below. That was his first step upward.

The reward was not long coming—an increase in salary. Then he was made Foreman. Now he is Superintendent.

It just shows what a man with ambition can do!

What about you? You don't *have* to stay down. You *can* climb to the position you want in the work you like best.

The way to do it is easy—without obligating yourself in any way, mark and mail this coupon.

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 7647-C, Scranton, Penna.

Without cost or obligation on my part, please tell me how I can qualify for the position or in the subject *before* which I have marked an X:

BUSINESS TRAINING COURSES

☐ Business Management	☐ Salesmanship
☐ Industrial Management	☐ Advertising
☐ Personnel Organization	☐ Better Letters
☐ Traffic Management	☐ Foreign Trade
☐ Business Law	☐ Stenography and Typing
☐ Banking and Banking Law	☐ Business English
☐ Accountancy (including C.P.A.)	☐ Civil Service
☐ Nicholson Cost Accounting	☐ Railway Mail Clerk
☐ Bookkeeping	☐ Common School Subjects
☐ Private Secretary	☐ High School Subjects
☐ Business Spanish ☐ French	☐ Illustrating

TECHNICAL AND INDUSTRIAL COURSES

☐ Electrical Engineering	☐ Architect
☐ Electric Lighting	☐ Blue Print Reading
☐ Mechanical Engineer	☐ Contractor and Builder
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☐ Machine Shop Practice	☐ Concrete Builder
☐ Railroad Positions	☐ Structural Engineer
☐ Gas Engine Operating	☐ Chemistry ☐ Pharmacy
☐ Civil Engineer	☐ Automobile Work
☐ Surveying and Mapping	☐ Airplane Engines
☐ Metallurgy ☐ Mining	☐ Agriculture and Poultry
☐ Steam Engineering ☐ Radio	☐ Mathematics

Name.....
Street Address..... 3-27-23
City..... State.....
Occupation.....
Persons residing in Canada should send this coupon to the International Correspondence Schools Canadian, Limited, Montreal, Canada.

CAR OWNERS WANTED!

To use and introduce the greatest improvement in Inner Tubes since autos were invented. Air gauge in valve stem of every Tube shows at a glance through the Unbreakable Transparent Valve Cover amount of air in tires. (5)

AIR-GAGE Heavy Duty Tubes

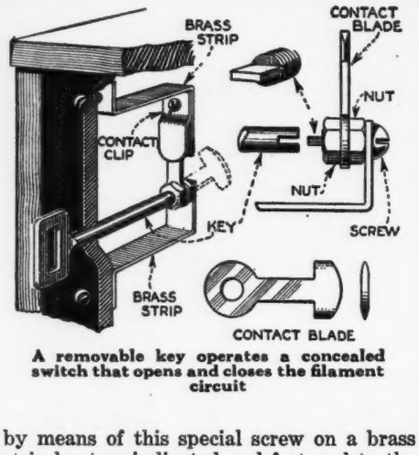
—sell on sight to almost every car owner because they save trouble, time, worry and expense. Add one-third to life of tires. Paul salesmen make big profits selling direct to car owners. Our million dollar factory can use 500 more salesmen at once. Experience not necessary. Big illustrated Free Book tells how the Paul Plan will start you in this big money-making business without capital. Write for Free Book Today.
THE PAUL RUBBER CO., Dept. 54, Salisbury, N.C.

THE HOME WORKSHOP

Simple Lock Prevents Tampering with Radio Receiving Set

THIS lock makes it possible to break the filament circuit of a radio receiving set in such a way that it can be closed again only with the key. Simple in construction, it can be made with materials found in every radio fan's workshop.

The key is round stock with a slot cut in the end to fit the end of a screw that is filed down as shown. A contact blade is pivoted



A removable key operates a concealed switch that opens and closes the filament circuit

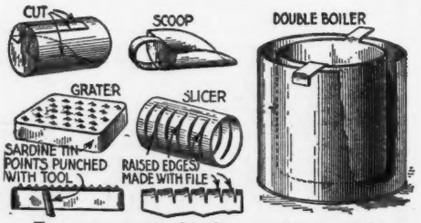
by means of this special screw on a brass strip bent as indicated and fastened to the back of the panel. A similar brass strip carries a contact clip so arranged that when the contact blade is turned up, it will enter the clip and close the circuit.

Only three holes have to be drilled in the panel to install this lock. If the cabinet has an easily opened top or back, it is necessary either to place the lock in a position where it cannot be reached without damaging some of the instruments and connections, or it must be boxed in solidly.—A. C. SELETZKY, Catonsville, Md.

Making Tin Cooking Utensils for the Vacation Camp

BECAUSE of the difficulty of carrying cooking utensils, campers are often hampered by the lack of necessary kitchen equipment. It is a simple matter, however, to improvise many of the needed utensils from empty tins.

A serviceable scoop is made by cutting a cylindrical can along the sides and turning



To save carrying kitchen equipment, the camper can make these and similar cooking utensils

back a portion of the metal to form a handle, as shown. The bottom of a sardine can serves as a useful grater if it is punched with a sharp tool or nail.

A vegetable slicer is made from a round tin by filing a series of grooves across it and bending the edges outward, as indicated. One tin inside another makes a good double boiler.

At the end of the trip these quickly made utensils are discarded.—C. L. S.

You Are Welcome Everywhere

Everyone should possess the ability to play some musical instrument. It will greatly increase your popularity and personal satisfaction. You are welcome everywhere with a sweet-toned

BUESCHER

Saxophone

It is the one instrument that anyone can play—the easiest of all musical instruments to master. With the aid of the first 3 lessons, which are sent without charge, the scale can be mastered in an hour; in a few weeks you can be playing popular music.

A Wonderful Entertainer

The Saxophone is the most popular instrument for home entertainment, church, lodge or school. You may readily add to your income if you desire, as Saxophone players are always in demand for dance orchestras.

FREE Trial—EASY Payments

You may try any Buescher **Saxophone, Cornet, Trumpet or Trombone** or other Band or Orchestral Instrument six days in your own home without obligation. If perfectly satisfied, pay for it on easy payments. Send for free Saxophone Book or complete catalog, mentioning instrument in which you are interested. (89)

BUESCHER BAND INSTRUMENT CO.
Makers of Everything in Band and Orchestra Instruments
3189 Buescher Block Elkhart, Indiana

TYPEWRITER Special SALE

A sensational Sale by one of the world's largest distributors.

LOWEST PRICES EVER OFFERED Thousands of these Standard Make, guaranteed, high grade, perfect typewriters have already been sold. The rest won't last long at our wonderful bargain price. Each machine goes out on 5 days **free trial** in your own home. If you are convinced it is the greatest typewriter you ever saw, you then start easy monthly payments. No red tape.

The supply at this price is limited

ACT QUICK Send for FREE Booklet of Valuable Typewriter Information and Special Sale Bulletin.

SMITH TYPEWRITER SALES COMPANY
321—360 E. Grand Ave., Chicago, Ill.

Genuine Aluminum Level

$3.95 NOW ONLY
DIRECT FROM FACTORY

Here is a special limited offer to introduce our new genuine Aluminum Level. Highest quality. A sensational offer. Non-adjustable, always accurate. Light weight. Fine for over-head work. Plain wire bubble-markers. Easy to read in poor light.

Two Year Guarantee Spirit tubes protected by glass lens on sides. Broken glass replaced within 2 years. Glass containers removable.

SEND NO MONEY

Just send your name and address. Pay postman on delivery. Use it and try it for 10 days. Send it back if you can purchase a better level for less or you are not entirely satisfied. 18 inch, 4 glass, **$3.95.** 24 inch, 6 glass, **$5.45.** 26 inch, 6 glass, **$5.95.** 28 inch, 6 glass, **$6.45.** 30 inch, 6 glass, **$6.95. Send Now.**

MASTER LEVEL & TOOL CO.
5926-A Seminole Ave. DETROIT, MICH.

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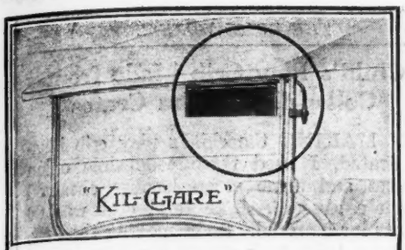
BIG PRICES PAID FOR DRAWINGS

Turn your talent into money. We can teach you drawing in your home during spare time. Well trained artists earn from $40 to $200 a week. Thousands of publishers and advertisers need the work of good artists. The **MODERN METHOD** is an easy way to learn to draw original pictures. Write today for full particulars showing opportunities for you.

State your age.

MODERN INSTITUTE OF ART
Dept. 3 7 East 42nd Street, New York City



Safety for Night Drivers

KILLS the blinding glare of oncoming headlights. Does not obstruct the driver's view. Easily attached to wind-shield. Swings quickly into position and as quickly out of the way. Simple and well made. Equally as effective against a bright sun. Price $3.50—the cheapest kind of insurance against night accidents due to the other fellow's headlights. By parcel post prepaid on receipt of remittance with order. Give make of car, closed or open.

J. B. Co.

399 St. Paul's Ave. JERSEY CITY, N. J.

BARGAINS IN REBUILT MOTORS

Limited stock, electric motors, rebuilt by our own experts and fully guaranteed, offered subject to prior sale, f. o. b. Chicago at the following extremely low prices:

	1/8 hp	1/6 hp	1/4 hp	*1/4 hp	*1/2 hp
A C—	$10.00	$12.00	$13.00	$24.00	$37.00
D C—	11.50	13.50	15.00	.....	.....

* Repulsion induction type.

Also a few larger sizes. Send Cash with order. Money back if not satisfied.

Northwestern Electric Co.

410-20 S. Hoyne Ave., Chicago, Ill.

Stop Using a Truss

Reduced Fac-Simile Gold Medal

STUART'S PLAPAO-PADS are different from the truss, being mechanico-chemico applicators made **self-adhesive** purposely to hold the distended muscles securely in place. **No straps, buckles or spring attached**—cannot slip, so cannot chafe or press against the pubic bone. Thousands have successfully treated themselves at home without hindrance from work—most obstinate cases conquered. **Grand Prix**

Reduced Fac-Simile

Soft as velvet—easy to apply—inexpensive. Awarded Gold Medal and Grand Prix. Process of recovery is natural, so after-wards no further use for trusses. We prove it by sending Trial of Plapao absolutely **FREE** Write name on Coupon and send **TODAY:**

Plapao Co., 790 Stuart Bldg., St. Louis, Mo.

Name .....

Address .....

Return mail will bring Free Trial Plapao.

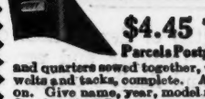
Cheapest Way to Go to work or school and recreation is on a Ranger bicycle. Choice of 44 styles and sizes. *30 Days' Free Trial.* Express prepaid.

12 Months to Pay if desired. Saved time and carfare easily meets the small payments.

Tires Parts, equipment—at half usual prices. Send no money. Write for our remarkable factory prices and marvelous terms.

Mead Cycle Company Dept. C196 Chicago Write us today for free catalog

You Can Save $35.00



$4.45 and up Parcels Postpaid

Recover it yourself. Custom tailor made to fit all makes and models. Roof and quarters sewed together, with rear fasteners, welts and tacks, complete. Anybody can put it on. Give name, year, model number of your car. Catalog *FREE. Agents wanted.*

LIBERTY TOP & TIRE CO Dept. E8 Cincinnati, O.

The Shipshape Home

How To Do the Odd Jobs

Removing Tile Paper

WHEN the home worker attempts to repaper a bathroom with the imitation tile paper so frequently used, he usually finds it next to impossible to remove the old paper. That is because the paper has a coat of water-resisting varnish.

The first step in removing it, therefore, is to take off the varnish. This can be done easily with strong household ammonia. The fumes are unpleasant, but the ammonia will take off the varnish, and then the paper can be soaked off with warm water to which a small amount of ammonia has been added.—R. T.

Filling Floor Cracks

BEFORE refinishing a floor, fill the cracks with a crack and crevice filler made by a reliable paint manufacturer or with a crack filler prepared by soaking white blotting paper in water, squeezing out the excess water, and kneading glue size and whiting into the paper until the mass is putty-like in consistency. Dry colors can be used to tint any crack filler to match the color of the floor.

When using a commercial crack filler, it is advisable first to paint the edges of the cracks with linseed oil. After the crack filler has set for about 24 hours, sandpaper the floor.—A. S. U.

Rubbing Varnish

IN ORDER to refinish furniture and to make repaired parts match old work, the home worker sometimes finds it necessary to duplicate rubbed varnish effects. This is not at all difficult if the varnish used is of a hard drying variety suitable for rubbing.

It is safer for the amateur to rub the varnish after it is thoroughly dry with oil and powdered pumice stone, although professional finishers use water with the pumice. Linseed oil cut with a little turpentine is rubbed over the work, and then the pumice is applied on a piece of felt or rag moistened with the same oil.

As in sandpapering, rubbing should be done in the direction of the grain. Angles and moldings should be cleaned out with a cloth wrapped around the end of a small stick.—E. H.

Repairing Flush Tanks

WHEN water runs continually from a flush tank, it is usually because the rubber ball that closes the outlet pipe has become soft and flabby or the wires connecting it with the handle require adjustment. Find out which it is and either replace the ball with another of the same size or bend the wires to work properly.

If the copper float ball leaks and allows the water to flow into the tank all the time, it can be replaced in an emergency with a pint flask or bottle. Unscrew the ball from the rod, make a hole in the flask's cork a trifle smaller than the rod, give the cork a coat of shellac, screw it on the rod, and then push the bottle on the cork. This will make a serviceable repair until the copper ball is mended.

He found it in Valparaiso

Then he headed north and found it up near the "jumping-off place"

No matter what part of the world you may find yourself in, few things make you feel more at home than to walk into a store and discover your favorite smoking tobacco for sale.

With your favorite tobacco in your favorite pipe, life is worth living in almost any corner of the globe.

This thought was inspired by the following letter from Mr. Bromley, an Edgeworth smoker from Fort Wayne, Ind.:

LARUS & BROTHER CO.,
Richmond, Va.
Gentlemen:

In some of your advertisements from time to time I have noticed letters from different users of Edgeworth Smoking Tobacco and I wondered if anyone ever had a more varied experience than I have had.

When in Valparaiso, South America, I could get it; and when I was as far north as a man could well go without going to the "jumping-off place," I could get Edgeworth Ready-Rubbed.

I have an old briar that I have had for ten years and it never had a crumb of any but Edgeworth in it.

If that isn't going some, "you tell me."

Yours truly,
(Signed) W. E. BROMLEY.

If Mr. Bromley makes frequent skips from continent to continent, his record of keeping all tobacco but Edgeworth out of his briar is indeed noteworthy.

But as a rule Edgeworth smokers, wherever they are, generally manage to find a way to get Edgeworth, for they don't feel as if they are really smoking unless the tobacco comes from a little blue can.

If you are not an Edgeworth smoker, send your name and address to Larus & Brother Company, 59 South 21st Street, Richmond, Va.

You will receive almost immediately free samples of both Edgeworth Plug Slice and Ready-Rubbed. Then you can judge for yourself what you think about this tobacco that so many smokers claim gives complete pipe-satisfaction.

If you will include the name and address of your regular tobacco dealer, your courtesy will be appreciated.

To Retail Tobacco Merchants: If your jobber cannot supply you with Edgeworth, Larus & Brother Company will gladly send you prepaid by parcel post a one- or two-dozen carton of any size of Edgeworth Plug Slice or Ready-Rubbed for the same price you would pay the jobber.

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42 Fittings included—fit all CARS

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DEALERS! Leading auto-makers have adopted "SAALS" as standard equipment. Standard Oil Co., Western Electric Co., and many similar corporations have equipped every truck with "SAALS." Coupon brings biggest profit-making opportunity of 1923. Mail it today!

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- ☐ Free Outfit Offer.
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Address.....

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Large shirt manufacturer wants agents to sell complete line of shirts, pajamas, and night shirts direct to wearer. Advertised brand—exclusive patterns—easy to sell. No experience or capital required. Entirely new proposition. *Write for free samples.*

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WARREN RADIO LOOP

Make Your Set Portable for Camping and Vacation

CONTINUE to enjoy the radio programs on your camping trip or wherever you spend your vacation. A Warren Radio Loop allows you to take your set anywhere. Sizes as small as six inches square, that can be fitted inside your cabinet. Send a postal for our Bulletin U-102, containing hookups.

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Type BL-2520 (200-18,000 meters) with honeycomb coil. 18 inches square—directional $25

Send for Bulletin U-102

V-DE-CO RADIO MFG. CO. Dept. O, Asbury Park, N. J.

THE HOME WORKSHOP

Child's Play Crib Made from Collapsible Onion Crates

IN MAKING the child's play crib illustrated, I used three collapsible onion crates and some scrap lumber obtained from a sawmill. The total cost was 60 cents for material. Since making the first, I have built four others for friends and received $3.50 for each.

The following material is required for one crib: 4 pieces 1½ by 1½ by 22 in. for corner posts; 2 pieces 1⅛ by ⅞ by 23 in. for top end rails; 2 pieces 1⅛ by ⅞ by 41½ in. for top side rails; 2 pieces 1½ by ⅞ by 23 in. for bottom end rails; 2 pieces 1½ by ⅞ by 41½ for bottom side rails; 26 pieces 1 by ½ by 18½ in. from onion crates for the uprights; ½-in. boards from old boxes to make the flooring, and 4 casters.

Total cost—60 cents for material

Mortises ½ in. deep are cut in the rails to take the uprights. Mortises are also cut in the posts to take the rails. The tenons on the bottom end rails are first fastened into the proper mortises in the corner posts with cabinetmaker's glue and then the uprights are put in place and the top end rails added. Each end is then drawn together with clamps, wire, or rope, or nailed to the floor until the glue is dry.

The side rails and the uprights are next glued together. The sides and ends are connected with dry mortise-and-tenon joint held with screws. This permits taking the crib apart for shipment and storage.

A ½ by ½-in. strip is fastened all around the bottom rails, ½ in. below their upper edge, to support the ½-in. flooring. Casters are added and the whole stained and varnished or enameled.—A. J. LOCHER.

Cheaply Made Hoist Saves Labor in the Home

MANY back-breaking jobs can be lightened by the simple hoist. It is made from a 25-cent clothesline pulley, attached by an S-hook to 3 ft. of 1-in. angle iron. A hole in the center of the angle iron takes a 7/16-in. pivot bolt. At the end opposite the pulley is a length of 1-in. angle iron bolted with a short ⅜-in. bolt at right angles to the main arm. This short piece butts against the porch ceiling when the hoist is being used. At other times the position of the hoist is as indicated by the dotted line.—S. HILLS, Torrington, Conn.

THREE or four lengths of dental floss or silk thread twisted together and waxed will form a strong and flexible string for restringing bead necklaces.—B. FOX.

THE HOME WORKSHOP

A Simple Horizontal Bar Serves for Stretching Exercises

HAVE you ever noticed how much better a good stretch makes you feel? The blood tingles to your fingertips and your head seems clearer. Stretching exercises are, indeed, considered among the most valuable, because they temporarily relieve the pressure on the spinal cushions and set the blood in vigorous circulation.

Hanging relaxed from a homemade bar

My family has been reaping the benefit of stretching exercises for several years by using a horizontal bar set up in a narrow hall. The hardwood bar, which is about 1⅜ in. in diameter and 3 ft. long, is supported at each end in a semicircular recess cut in a wooden block 1 by 3 by 12 in. The two brackets are fastened to the walls opposite each other to support the bar about 7 ft. 8 in. above the floor, and are screwed solidly through the lath and plaster into the studs with 3-in. screws (see illustration above).

The bar is held in the recesses by two metal clamps, obtained at a hardware store. If an expansive bit is at hand, a hole can be bored in each of the blocks and the clamps done away with.

I don't recommend attempting to chin the bar unless you are athletically inclined. Just hang completely relaxed and when fingers and arms are tired, drop down and rest.

If an additional exercise is desired, try arching the back with shoulders back, chest out, and draw up the feet as far as possible, relaxing slowly to first position.—R. W. THOMPSON, New York.

Summer Features in the August Home Workshop

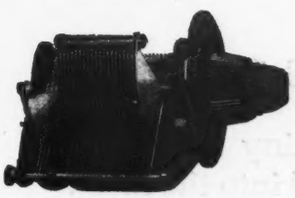
A WEALTH of "how to make" material will appear in the Home Workshop Department of the August POPULAR SCIENCE MONTHLY.

One article will give details for the ideal vacation radio outfit—a one-control, dry-cell set that fits a 7 by 8 by 10 in. cabinet. Another will tell how to build rustic furniture for the camp.

Other stories contain constructional details of a unique sailing raft for swimmers, a small ornamental fountain, a power-driven lawnmower, and a floating camp.

Kellogg Radio Equipment For Better Results

No. 69A Head Set



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Your receiving set is not complete without a Kellogg No. 69A head set. A few minutes listening-in will convince you of its merits.

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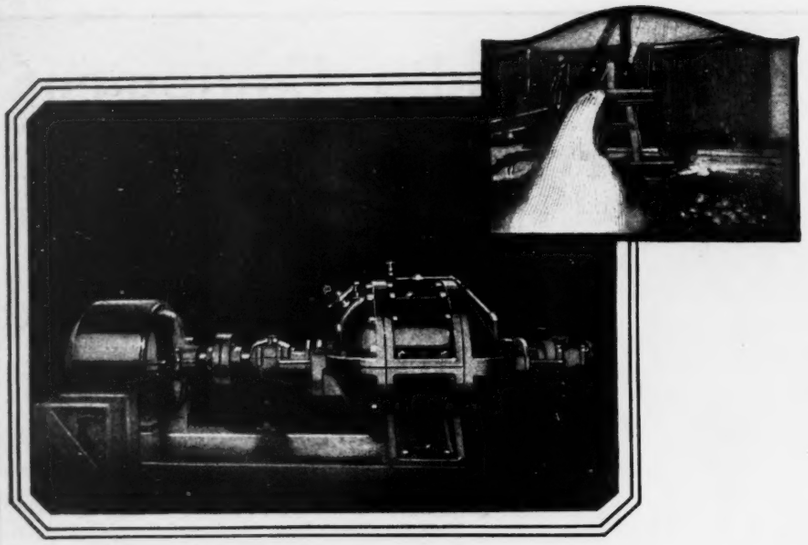

Who started this pump?

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